AD699125

TM-4023/005/00

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National Data Program for the Marine Environment

Volume One Final Report

July 31, 1969

Insert on inside front cover

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This study was financed by a contract with the National Council on Marine Resources and Engineering Development, Executive Office of the President. However, the findings, recommendations, and opinionsin the report are those of the contractor and not necessarily those of the Council, nor do they imply any future Council study, recommendations, or position. All funding information is a projection by the contractor based on published information and anticipated trends in the marine data field. It is hoped that this study will contribute to the full discussion of problem areas and issues in marine science affairs.

These reports, Volumes One and Two, Phase II, National Data Program for the Marine Environment, Technical Development Plan, supplement the 1 December, 1967 edition, Volumes One and Two, Phase I, National Data Program for the Marine Environment, AD 673-992 and AD 673-993.

TM-4023/005/00

TECHNICAL MEMORANDUM

(TM Series)

This document was produced by SDC in performance of contract N00014-67-C-0559

NATIONAL DATA PROGRAM
FOR THE MARINE ENVIRONMENT

FINAL REPORT

VOLUME ONE

July 31, 1969

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CORPORATION
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SANTA MONICA
CALIFORNIA
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This study was sponsored by the National Council on Marine Resources and Engineering Development under Office of Naval Research Contract Number N00014-67-C-0559 and Contract Authority Identification Number ONR-620:FDB.

ERRATA

The following corrections (indicated by an asterisk) should be made on the indicated pages.

VOLUME I

Page II-13

(Construction Division) should be (Conservation Division)*

Page III-5, Table III-2 (cont'd)

	Volume
* RAOB Significant Levels	2,000 000 * (approximate) observations

Page III-18, Table III-5

		Total
Extended Range Weather Forecasts	NMC	5.48 * X 10^3

Page A-2

ESSA Environmental Data Service
Silver Spring, Maryland

* General Ben Holzman

Page IV-51, Table IV-24

FY	*Additional Personnel Costs (Millions)	*Total Annual Budget (Millions)
71	.260	3.838
72	.290	4.039
73	.185	4.121
74	.185	4.318
75	.185	4.525
76	.260	4.817
77	.305	5.590
78	.290	5.314
79	.290	5.565
80	.290	5.829

Page IV-141, Table IV-49

Heading should be changed from:

Existing NWRC Budget
(Millions)

To:

Existing Marine Climatology Budget
(Millions)

ADDENDUM

The following Federal Agency comments are intended to clarify the indicated texts.

VOLUME I

Page 19

Paragraph 2 - Substitute "all" for "non-defense".

Page II-12

Add to the marine activities for which the U.S. Geological Survey is responsible:

Lead agency responsibility for coordination of water data acquisition activities on streams, lakes, reservoirs, estuaries, and ground waters (BoB Circular A-67).

Page II 13, Paragraph 3 and
Page V-50, Paragraph 3

The USGS, in accordance with its responsibility for the appraisal of water resources and for coordination of Federal water data acquisition activities, collects, interprets, and disperses data on the quality and quantity of water, including estuaries, lakes, and the subsurface.

VOLUME II

Page IV-33, Table IV-15

The Coast and Geodetic Survey feels that the following change is a more accurate assessment of the situation.

FY	71	72	73	74	75	76	77	78	79	80
Reduce Time Interval Between Resurveys (Years)			200	150	130	110	90	70	60	50

PAGE IV-139

Last paragraph - Add "and continues the existing marine climatology program." to the sentence now ending "... implementation schedule (Table IV-48)."

VOLUME II

Page IV-35, Table IV-16

New Bathymetric Data Generation and Storage Requirements
(Digital Data from Sea)

FY	71	72	73	74	75	76	77	78	79	80
Soundings (M)										
*		(information on Bits (M) deleted)								
*Characters (M)	300	315	330	348	366	348	402	423	444	465
*Cumulative Characters (M)	300	615	945	1293	1659	2043	2445	2868	3312	3777
*Number of Tape Reels (M)	10	21	32	43	55	68	81	96	110	126

Page IV-42, Table IV-20

FY	*Software Personnel Costs (Millions)	*Computer Operations Personnel Costs (M)	*Total Annual Shipboard Systems Data Processing Cost (Millions)
71	.195		1.523
72		.110	1.975
73		.120	2.000
74		.030	1.820
75		.040	1.845
76		.050	1.870
77		.060	1.780
78		.070	.677
79		.070	.190
80		.070	.190

ACKNOWLEDGEMENTS

The assistance and advice of all agencies participating in this study is gratefully acknowledged. In particular, we acknowledge the assistance provided by the individuals named below.

National Council on Marine Resources and Engineering Development
Mr. John Fry, Technical Director

Data Management Advisory Panel and Observers
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Hunter College

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Office of Science and Technology

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Smithsonian Institution

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National Oceanographic Data Center

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Chevron Research Company

Mr. Melvin Burkhart
Office of the Oceanographer of the Navy

Dr. J. Lockwood Chamberlin
Bureau of Commercial Fisheries

Mr. James Churgin
National Oceanographic Data Center

Captain Robert P. Dinsmore
U.S. Coast Guard

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U.S. Naval Oceanographic Office

Mr. Walter A. Hahn
Environmental Science Services Administration

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Miss Mary Johrde
National Science Foundation

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U.S. Coast Guard

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U.S. Atomic Energy Commission

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VOLUME ONE

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EXECUTIVE SUMMARY

IMPROVING MARINE DATA MANAGEMENT

The United States has a new mandate for the expansion of ocean related activities. The Marine Resources and Engineering Development Act of 1966 (PL 89-454) calls on the President to develop a comprehensive, long range, and coordinated national program in marine science with the assistance of a National Council on Marine Resources and Engineering Development, and an advisory Commission on Marine Science, Engineering, and Resources. The Council is composed of the Vice President of the United States, who serves as Chairman, five members of the President's Cabinet, and three heads of other Federal agencies It has statutory responsibility to advise and assist the President in policy planning and the coordination of marine science affairs.

The new marine sciences policy is unprecedented in its breadth. It continues the quest for scientific knowledge of the marine environment but marks a significant transition toward applications through strengthening ocean engineering and marine resource development to:

- Contribute to national security
- Enhance commerce and transportation
- Rehabilitate domestic fisheries and increase the harvest from the sea
- Develop seashore resources and reduce pollution of the Great Lakes, bays, estuaries, and nearshore waters
- Improve forecasting of weather and ocean conditions
- Supplement continental sources of oil, gas, and minerals
- Promote international understanding and cooperation through use of the oceans

The marine science effort, reinforced by many scientific and engineering disciplines and technologies, involves a wide diversity of institutions, including Federal departments and agencies, committees of the Congress,

major U.S. industries, and numerous State, regional, and international organizations. (See Figure 1 for Participants in Marine Sciences.) Private sector participants include many of our universities and maritime, construction, chemical, electronics, aerospace, mineral, oil, fishing, recreational, and other industries. One significant purpose of the Act is to achieve a creative and cooperative partnership among the government, business, academic scientific, and engineering communities.

The 1966 Act recognizes that an expanded and coordinated national ocean program can contribute to achieving major national goals. A vigorous program of marine research, development and exploitation has thus been launched to ensure that the bountiful resources of the sea contribute to solving man's increasing needs for food, water, minerals, and energy. The new national policy will accelerate the conversion of the relatively unfulfilled promise of the sea to nationwide benefits.

Federal support for marine R&D has increased from $438 million in FY 1967 to $528 million in the President's budget for FY 1970, and is the fastest growing sector of the Federal R&D budget. In January, 1969, the Marine Sciences Commission recommended an $8 billion investment in civil-oriented marine science activities during the next decade. The sharp upward projections of funding for marine science affairs is depicted in Table 1. At this stage of its development, and for the next ten years, marine science programs will be primarily data and information oriented. There will thus be accelerating needs and opportunities for new and improved data management systems and services.

Vast quantities of marine-oriented information are required to support virtually all purposes of marine science and technology. These include:

- Environmental data--real-time and archival--concerning the nature of the oceans and the interactions of man's activities with the marine environment.

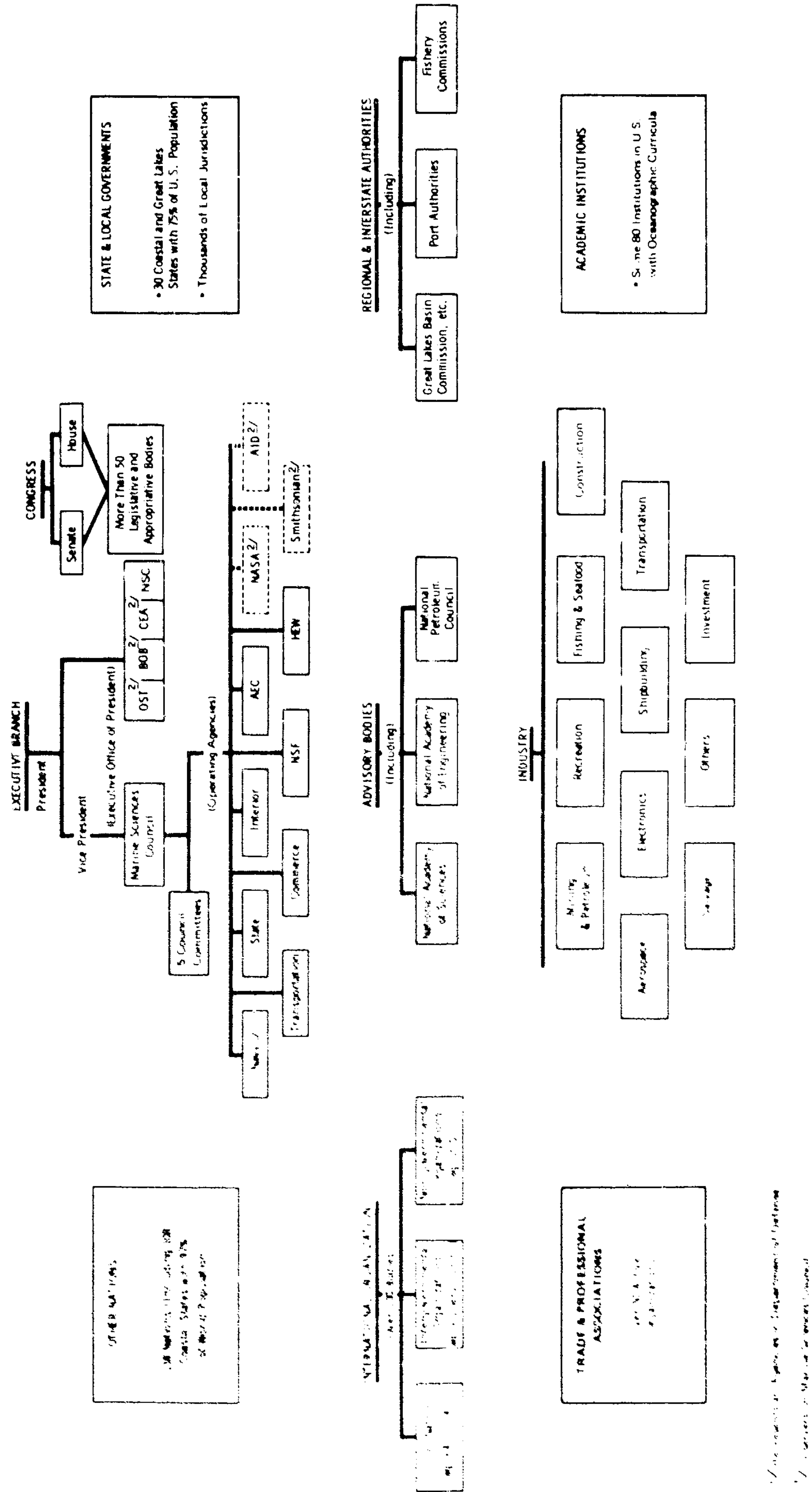


FIGURE 1. PARTICIPANTS IN MARINE SCIENCES

TABLE I

COSTS FOR COMMISSION RECOMMENDATIONS (BY ACTIVITY)*

(Incremental Costs in $ Millions)

Activity	Average Annual Costs 1971-1975	Average Annual Costs 1976-1980	10-Year Total Costs
All Commission Recommendations	652	948	8,000
Management and Operations	62	70	660
Research and Education	142	226	1,840
Specific Technology Programs	124	182	1,530
National Projects	160	215	1,875
Fundamental Technology	130	210	1,700
Mapping, Charting, and Surveying	34	45	395

*These Commission recommendations reflect only Federal nondefense programs. The Defense segment is expected to grow at a slightly higher rate during the projected periods.

- Bibliographic and documentation information.
- Program management and budget information about past, present and projected activities.
- Statistical, economic and demographic information concerning man's activities that impinge on or are affected by marine operations.

Many data requirements as well as data collection and distribution needs are common to numerous organizations, both Federal and non-Federal. Producers and users of data now include more than 30 bureaus in 15 Federal departments; 30 coastal and Great Lakes State governments concerned with developing and regulating the use of marine resources; 250 Federal, State, academic and private laboratories involved in marine research and engineering development;

1,100 merchant ships; an ever-increasing number of offshore oil and mineral operations; several million sport and commercial fishermen; tens of thousands of Navy men in our fleets; and more than 7,000 scientists, engineers, specialists, technicians and others engaged in marine research and development activities. Each is concerned with obtaining marine data or data products and services to meet his own particular needs. The problem of responding to these needs is illustrated in Figure 2.

Advances in marine science and technology depend critically upon the effective flow of information--from data collectors to data consumers. Today, with broader ocean-related activities and with data acquisition more complex and costly, the data commodity must be shared among a larger number of participants. More efficient recording, archival, processing and distribution systems are needed to provide information services not only for the oceanographic community, but beyond it to a larger community of State and industrial users, and public and private interests concerned with maritime policy and economic development. If we are to understand the complex nature of the marine environment and if understanding is to foster achievement of practical national goals, information must both be generated and made available to meet a wide variety of user needs.

Apart from increases in the size and complexity of the data community, increases in data traffic and changes in the character of data impose new problems in data management. The advent of simultaneous measurements at numerous locations and the evolution of requirements to monitor the marine environment with ocean data buoys and spacecraft sharply increase the sheer quantity of information to handle. The complexity of marine data management can be illustrated by the variety of observable quantities and the diversity of their sources and end-uses. Data are obtained from the world oceans, coastal waters, estuaries, and Great Lakes by:

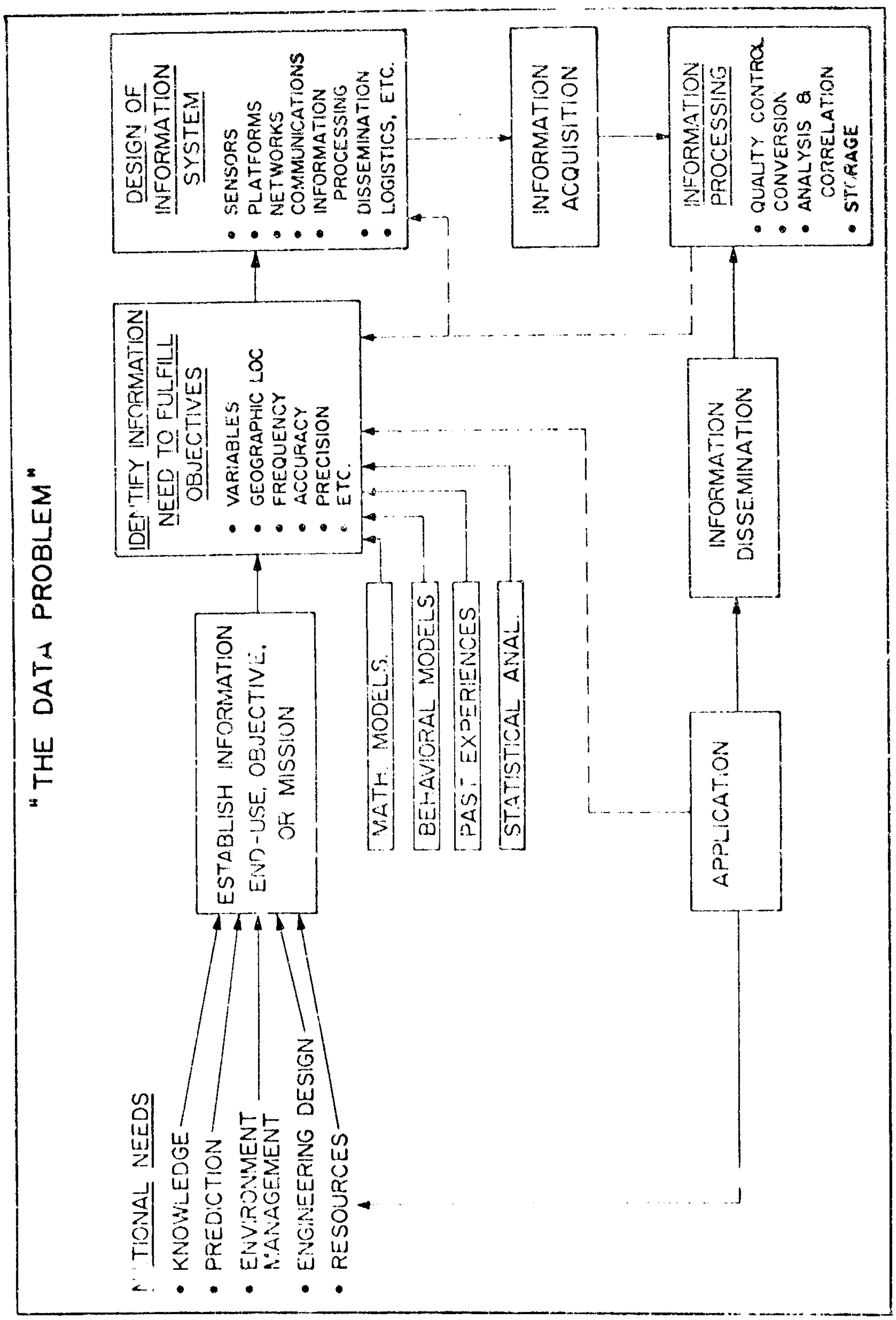


FIGURE 2. MARINE SCIENCES INFORMATION MANAGEMENT[1]

[1] The First Report of the President to the Congress on Marine Resources and Engineering Development, January 1967.

- Research and survey ships, offshore platforms, submersibles, and divers.
- Ships of opportunity in the merchant marine, Navy, Coast Guard, and commercial fisheries.
- Spacecraft, aircraft, and buoys.

Data may be real time or archival; may be presented in the form of maps, documents, visual displays, analog or digital records; and may consist of sea water, biological or geological samples. Exploration of the oceans has not always been fully coordinated and agreement within the marine sciences community as to data handling procedures and standards has not been broadly achieved. Meanwhile, technology makes it possible to accumulate data at a vastly faster rate. Data users are thus frequently unaware of existing sources, and are unable to retrieve needed data quickly in a readily usable form. In other cases, data may be deliberately rejected because of doubts of its validity. These problems demonstrate the needs of all sectors of the marine science community. Innovative data management programs can be developed for their solution.

Several Federal data centers have been established to meet a demand for improved data services. These facilities almost immediately became inadequate as the result of inadequate funds as well as insufficient national data bases, incompatible data formats for efficient exchange, delays in filing, archaic processing and communication methods, and lack of critical evaluation. An increasingly serious problem for the future is how to manage an even larger volume and diversity of marine data which are certain to result from intensified activities and new technologies. Effective data services that afford prompt and reliable dissemination should be developed to match the speed and sophistication of data acquisition if the benefits of new technologies are to be realized. Such services must be planned not only for the present but for the next ten years.

The System Development Corporation, under contract to the Marine Sciences Council, is submitting this report on a recommended National Data Program for the Marine Environment, projecting on an agency-by-agency and marine program basis the increased funds and other resources required to upgrade the quality of the more important marine data management activities and other services, commensurate with the expanded program proposed by the President's Commission.

The sphere of Federal marine data management activities is vast and the time is ripe for providing the catalyst required to accelerate its orderly development. It is hoped that the SDC report will provide this catalytic effect and dictate the future success of marine data management affairs within the Federal Government.

MAJOR RECOMMENDATIONS

The purpose of this section is to provide a summary of the major recommendations which have been developed during the course of the project. These recommendations are based on detailed analyses and findings presented in the body of the report. The recommendations are presented here for the convenience of the reader who wishes to capture the principal issues which carry policy implications for future action.

These recommendations are based on the general conclusion that the nation is not getting full value from the marine data which have been collected and continue to be collected in ever greater volume. Budgets for data preparation, storage, retrieval and analysis are consistently assigned low priority. National data centers do not have the equipment or personnel to provide desired services. Ocean observations may be duplicated through lack of knowledge about available data sources and holdings. Data collected from many research expeditions or development programs are often communicated to the national data archives reluctantly, late, or not at all. Recognition of this situation, and corroboration of this conclusion, is found in the reports published in accordance with the Marine Resources and Engineering Development Act of 1966 (Public Law 89-454), which established the National Council on Marine Resources and Engineering Development, and the Commission on Marine Science, Engineering and Resources.

We therefore consider it of urgen[illegible] priority to adopt technical improvement programs in the principal marine data service organizations, to strengthen the capabilities of national data centers, and to tighten the Federal administrative machinery relating to the marine data network. These actions will significantly increase the value of marine data to the many user groups who comprise the constituency of marine science activities, and

enhance the United States' position in the international marine science community.

Recommendation: <u>Authorize prompt implementation of the Technical Development Plan.</u>

The Technical Development Plan (TDP) for a National Data Program for the Marine Environment is summarized in Chapter VII, and elaborated in Volume II of the report. It specifies product improvements, new products, data requirements, and implementation requirements for each major Federal marine data service organization for the ten-year period Fiscal Year 1971-1980. A minimum investment in needed product improvements over this period will require an estimated incremental cost to the government of $184 million above present levels (Plan A). Implementation of a plan for product improvements, new products and improved user services will require an estimated incremental cost over the ten-year period of $372 million above present levels (Plan B). Implementation of the recommended complete plan for product improvements, new products and services and new data acquisition networks will require an estimated incremental cost over the ten-year period of $496 million above present levels (Plan C).

Implementation of the recommended complete TDP will produce vitally needed upgrading of existing marine data products and services, and development of capabilities for improved systems for future data management and product preparation. In addition, the TDP includes recommendations for funds to support developmental planning of data management capabilities in the national data centers so that more powerful and responsive services may be provided to the expanding user community. Data centers must attract and retain first class data managers. The expenditure of funds for these purposes will return benefits to marine sciences and the user community at large that will far outweight the dollar cost, and will improve the currently inadequate capabilities for exploitation and dissemination of data in order that balance be achieved with necessary increases in data collection. In the

event that additional monies are not allocated to the marine data management, it is essential that this field be strengthened by the reprogramming of authorized appropriations to the Federal agencies.

Among the major technical recommendations of the TDP are the following:

1. Jointly between the Federal government and the States, develop a new unclassified product, a nearshore coastal zone atlas, or coastal atlas, consisting of information on climate, recreational facilities, geography, coastal developments, fishery statistics, landmarks, hazards to navigation, geological features, and marine environmental and bathymetric data. (See TDP-C&GS.)

2. Undertake the development of new satellite products which combine digital meteorological data with satellite imagery data. (See TDP-NESC.)

3. Reduce time delays in revision, increase geographic coverage and resurvey frequency, and enlarge the scales of Coast and Geodetic Survey nautical charts and small craft charts. Expand the bathymetric mapping of the continental shelf (See TDP and Chapter V-C&GS.)

4. Reduce time delays in revision, increase geographic coverage, and enlarge the scales of Naval Oceanographic Office nautical charts, and increase the timeliness of Notice to Mariners. (See TDP-NAVOCEANO.)

5. Expand the scope of products and services provided by the Great Lakes Regional Data Center and the Lake Survey to include ice atlases and charts, surface current charts, bathymetric maps and a Great Lakes climatological atlas. In addition, develop data bases for water

pollution, ice and snow, waves, surface currents, river flow, and bathymetry for the Great Lakes region. (See TDP and Chapter V-LS and GLDC.)

6. Develop and maintain a series of ocean engineering reports and reference services containing information on design criteria, test results, the effects of the marine environment on vehicles, structures and instrumentation, to supplement the standard references available from commercial sources. (See TDP-NAVOCEANO.)

7. Establish a national system for the automatic acquisition and processing of coastal wave and surface meteorological data. (See TDP-CERC and Weather Bureau and Chapter V-CERC.)

8. Establish a national system of regional fishery data and statistics collection, communication and processing facilities. (See TDP-BCF and BSF&W and Chapter IV-Fishery Statistics Report.)

9. To the extent possible, expand capabilities and coverage of seasonal fishery advisories, preseason abundance forecasts, and fishery resource atlases to all major fisheries. These should be followed up by an evaluation of their accuracy and usefulness. (See TDP-BCF and BSF&W and Chapter IV-Fishery Advisories Services and Preseason Abundance Forecasts.)

10. Establish more automated linkages among the following marine data service organizations: National Oceanographic Data Center (NODC); National Weather Records Center (NWRC); Fleet Numerical Weather Central (FNWC) of the Naval Weather Command; and the Great Lakes Regional Data Center (GLRDC) of the U.S. Lake Survey. Establish similar linkages between NODC/NWRC/SOSC and their recommended regional offices: Woods Hole Oceanographic Institution, Scripps Institution of Oceanography, University of Washington, Oregon

State University, Texas A & M University, University of Michigan University of Miami, and the Lamont-Doherty Geological Observatory. These linkages may be conventional teletype at first, and later upgraded to remote terminals for automated query of computer-searchable data files. (See TDP-NODC, NWRC, and SOSC.)

11. Expand automation of the data inventories at the National Oceanographic Data Center (NODC) to permit derivation of statistics concerning the availability of collected data by lateral and vertical coordinates, type of platform, instrumentation, data collection agency, and schedule of acquisition. (See TDP-NODC.)

12. Distribute fact sheets of marine instrumentation characteristics developed at the National Oceanographic Instrumentation Center to NODC for dissemination to data requesters. This information should be recorded in the data bases maintained at NODC, enabling correlation of instrument characteristics with data values for release to requesters. (See TDP-NODC.)

13. Implement a program for significantly increased collection of surface temperature, water temperature, sea state and surface meteorological parameters from ships and aircraft, emphasizing the use of expendable instruments and digital recording and transmission. (See TDP-FNWC and NMC.)

14. Establish National Data Buoy System shore-processing centers and data transmission facilities for the management of buoy data after they reach shore. (See TDP-USCG.)

15. Provide increased capabilities for the STORET water quality data system including the installation of sensors and telemetry equipment at selected estuaries for the automatic acquisition and transmission of data. (See TDP-FWPCA.)

Recommendation: <u>Establish a permanent mechanism for Federal coordination of marine data management</u>

During the course of the study, the contractor found it invaluable to have one office--the National Council on Marine Resources and Engineering Development--with which planning and policy formulation could be conducted, and the Data Management Advisory Panel (DMAP), made up of professional and scientific representatives from the major government agencies involved in marine sciences, with whom to review technical problems which arose during the study. Hence, this recommendation consists of two parts: first, that one office be designated for cognizance of policies applicable to marine data management activities, and second, that an advisory committee, representing the professional and scientific community, be continued on a permanent basis.

Specific responsibilities of the advisory committee would be those of technical review of progress toward and agreement on solutions to problems that arise in improving data management programs. For example, establishment of standards for quality control in collection of marine data, standards for compatibility of formats in data codification and inventory control, scales and projections for map and chart production, new marine data product specifications, and means for achieving real-time linkages among computer-based files of marine data, would all be appropriate for this committee. Composition of the committee should not be limited to the Federal Government. Rather, explicit and broad representation of the non-Federal marine data producer and user community should be required, with provision for employment of expert consultants as appropriate. Data systems specialists should be included in committee representation. Consideration should be given to the representation of the committee on the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology, Office of Science and Technology, Executive Office of the President.

It is suggested that the appropriate designation of the first office be within the Executive Office of the President, more particularly in the National Council on Marine Resources and Engineering Development, unless and until a new office or agency is formed for the purpose of coordinating national marine science activities. The chairman of the advisory committee need not be a member of the Council, but the committee should be available to the Council for consideration of problems and progress in marine data management, and the Council should provide required staff support. (See Chapter VII and TDP-Chapter V.)

Recommendation: Substantially increase the authority and responsibility assigned to the existing national data centers.

The major problem of marine data management is the diffusion and fragmentation of data sources, services and responsibilities. As the Report of the Commission on Marine Science, Engineering and Resources points out: "At present, there is not even a comprehensive index which can tell a potential user what data exist and where, let alone an orderly and expeditious flow of data between facilities and to national data centers equipped to disseminate data to the user community."

The Commission Report makes a distinction which is supported by the present study and with which we concur: mission-oriented agencies, sometimes referred to as primary centers, such as the Weather Bureau and its associated National Meteorological Center, or the research and development laboratories of the U.S. Navy, should not be impeded in any way in the prosecution of their mission responsibilities. However, the secondary centers, of which four are generally acknowledged as national data centers--National Oceanographic Data Center (NODC), National Weather Records Center (NWRC), Smithsonian Oceanographic Sorting Center (SOSC), and the Great Lakes Regional Data Center (GLRDC)--have been crippled by chronic lack of funds and authority to discharge their increasingly vital functions of analysis, storage, and dissemination of marine data. In Fiscal

Year 1969, the National Council on Marine Resources and Engineering Development has estimated that direct Federal appropriations for these four centers were $2.33 million out of a total Federal budget for marine science and engineering development of $471.5 million. Federal appropriations to the centers were augmented by contracts with executive agencies, by agreements for reimbursement for specified services, and by use-charges to customers. Nonetheless, none was able to operate at the scale implicit in its charter and with the degree of responsiveness desired by the user community. This is particularly troublesome because these are the centers with which the community of marine scientists and marine industrial development have the most occasion to interact and upon whose services these user groups evaluate the entire marine data management program in government.

A number of specific suggestions will clarify the intent of this recommendation.

1. Authorize and specify that a portion of the funds awarded in marine science contracts are to be used for data preparation and data communications to and from national data centers. The Federal Government is the principal funding agency for the conduct of marine science at research institutions, yet there exists no effective incentive for these institutions to spend a portion of these funds on the tasks of data preparation and communication to national data centers.

   The responsibility for obtaining data for archiving is that of the national data centers. Economy dictates, however, that research institutions be encouraged to perform as many of the tasks of data preparation and routine communication to the centers as possible. Contract provisions in and of themselves may, and probably will, prove to be inadequate. In addition, it is suggested that at least the major research institutions be specifically funded or reimbursed for the costs of establishing technical data centers representing their own specialized holdings,

maintained in data formats and media compatible with those of the relevant national data centers. This will relieve the individual scientist of the obligation for data preparation and communication to the centers, and enable specialized technical personnel to be employed for this function.

2. Exercise the Government's legal authority to require the preparation and communication of marine data to national data centers, if collection is Federally financed.

3. Provide for liaison participation of the national data centers in the planning of data collection for research programs for the purpose of developing a complete plan for data acquisition, communication of data to national data centers, and subsequent processing and dissemination of data to users. Implementation of this suggestion will require that the data centers develop and provide skilled advisory services to those responsible for planning data collection research expeditions.

4. Emphasize and strengthen the research functions appropriate for the intramural staff of the national data centers. This research consists of two kinds: research in the techniques of data management, which requires experienced and capable information system design specialists; and research in the analysis of substantive data included in the holdings of the center, leading to development of products, which require subject matter specialists in the appropriate natural and biological sciences. Implementation of this suggestion could be achieved either by direct hire or by personnel rotation exchange with other government agencies and research institutions.

5. Address the problems of availability and transfer to data centers of industrial marine environmental data, and establish mechanisms for the acquisition of relevant, available defense data. The former may require reimbursement to industrial organizations who have undertaken marine data collection programs; the latter may require the development of procedures for "sanitizing" certain classified data such that military weapons systems performance characteristics are deleted or obscured. In both cases, it is our impression that substantial bodies of data are available and releasable, but that no procedure has been established to facilitate their communication to the appropriate national center. (See TDP-USGS.)

6. It is suggested that NODC be designated the lead agency to establish regional offices--not regional data centers--at or near major marine science research institutions, with NWRC and SOSC as participating agencies. These offices would provide more direct and personal liaison with users and more direct data acquisition for NODC data bases and would serve as information centers for referral of inquiries to NODC and other data centers. It would be desirable for these regional offices to have direct teletype communications to NODC, and they may later be connected by remote terminal directly to the NODC computer for query and printout of substantive material. The concept of a resident liaison representative has been tried out, with good results, at Woods Hole Oceanographic Institution for the past year and has recently been extended to the Scripps Institution of Oceanography. Other appropriate research institutions are the University of Washington, Oregon State University, Texas A & M University, University of Michigan, University of Miami, and the Lamont-Doherty Geological Observatory.

The suggestion for regional offices rather than regional data centers is quite deliberate, if we understand a regional data center as maintaining data holdings which duplicate some or all of the data holdings at NODC. Regional data centers may evolve as more effective computer networking technology is developed. For the present, however, adequate proof of such networking capability at the required level of operational reliability is lacking. Perhaps even more pertinent is our opinion that investment in regional NODC data centers at this time would simply divert funds and resources urgently needed at NODC itself and would further delay the development of needed capabilities at the national center. (See Chapter V-NODC and TDP-NODC, NWRC, SOSC.)

Recommendation: Designate a national ocean engineering data referral center.

Ocean engineering data is the major class of data for which there is presently no Federal focus of data management responsibility in evidence. Further, ocean engineering data are becoming more important to the user community as new submersibles are being developed, offshore oil and gas exploration expands, marine mineral extraction is increased, and additional ocean platforms are developed for environmental reporting, etc. Such a data center would make available to non-defense users ocean engineering reference services for technical reports; information on the effects of the marine environment on vehicles, structures and instrumentation, physiological data, accident reports, etc.

Candidates for designation as a national ocean engineering data referral center include NODC, the Coastal Engineering Research Center (CERC) of the Corps of Engineers (for coastal zone data) and the Office of the Assistant Oceanographer of the Navy for Ocean Engineering Development (which has access to deep ocean data from a variety of defense projects). At the moment, NODC has neither the basic data files nor personnel expertise in ocean engineering. Nevertheless, in order to reduce further proliferation of centers, we suggest that NODC operate as a referral center for non-defense ocean engineering users,

drawing upon the capabilities of CERC, USGS, and the Navy for source data and assistance. (See Chapter V-NODC and TDP-CERC, USGS, NAVOCEANO and NODC.)

Recommendation: Develop and maintain a comprehensive inventory of marine dat holdings, samples, products and publications.

The need for an inventory of marine data holdings, samples, products and publications has become increasingly evident. Preliminary studies by the Ocean Center of the Office of the Oceanographer of the Navy and by the System Development Corporation indicate that the number of organizations, including major libraries, maintaining significant specialized marine science holdings is well in excess of 10,000. To the user, it is important to know where to turn for the data, samples, products and/or publications of immediate need. To the producer, it is often equally important to know where to send marine data so that they will be available to interested user groups. At present, no inventory exists of these organizations and their holdings. The preliminary work performed by the Ocean Center and SDC forms a beginning, but needs to be completed, and very possibly extended and maintained on a periodic basis thereafter. NODC is recommended as the responsible Federal coordinating agency with substantial participation by USGS and SOSC. This directory would include descriptions of Federal data bases as described under Master Marine Data Base Directory in the NODC TDP.

A significant step toward the preparation of the initial inventory could be achieved if the Federal Government were to reimburse research institutions and private organizations for publishing current data and sample holdings. This would involve only a modest cost, but would provide a much-needed resource to the Government. These publications would bring to light the description of characteristics of the holdings of thousands of organizations and research scientists, and would expedite completion of the desired inventory.

After an initial inventory is completed, it is recommended that consideration be given to an automated reference system for correlated retrieval of data and sample information (association of environmental data with sample information), including a description of the conditions of collection (such as the agency, platform and instrumentation), bibliographic references to products, and reports and documents which have been published on the basis of the data and/or samples. We recognize that this is an undertaking of substantial magnitude, and careful evaluation may prove that the benefits to be derived limits its scope to specialized areas of application such as defense weapons systems research and development. (See Chapter V-NODC and TDP-USGS, SOSC and NODC.)

Recommendation: Strengthen Federal/State relationships in the acquisition of marine data and the provision of data services.

By law, the States are responsible for re urce management and conservation of the coastline, tidelands, and of the lands surrounding the Great Lakes. The coastal and Great Lakes regions are now, and will be even more, important to the nation as increasing proportions of the population inhabit them. The ability of the States to undertake farsighted, consistent programs of conservation and pollution abatement has not been demonstrated to date. Even within the States, a variety of agencies are typically involved in the matter. In the State of California, nine separate agencies are producers and/or users of marine data for resource planning and management. No one of these agencies knows fully what data are available or of interest to the others, and the Federal Government does not possess an adequate inventory of the State's data files or needs. The situation is similar elsewhere.

It is suggested that the Federal Government inventory existing State marine data programs and files, and actively promote consistent data collection and data management practices. Federal grants for this purpose, calling for matching funds from the States, would appear to be a cost/effective way to establish closer working relationships in this important area. An existing administrative mechanism that could be used to accomplish this recommendation

is the network of State Technical Information Reference Centers operated with the Federal assistance of the Department of Commerce.

Recommendation: Complete the installation of on-board data processing systems on Federal oceanographic expedition ships.

On-board data processing capability for oceanographic survey and expedition vessels is well established in the technology. The advantages of on-board processing include immediate verification of data quality, the opportunity to adjust data sampling design in real time, on-board product generation, and the expeditious processing of data for transmission to shore-based facilities for later detailed analysis. Some of the newer survey ships are not fully instrumented with the on-board data processing available and desired, and older ships are being retrofitted with such data processing systems very slowly. It is recommended that direction to complete an on-board data processing implementation program be given to the Federal agencies and laboratories.

We recognize that within the next decade, developments in satellite communications will almost certainly advance to the stage at which bulk transfer of survey data to shore-based processing and analysis centers will be operable and economical. While this mode of data processing will affect the rapidity of large-scale data analysis and improve the efficiency of much of the marine data product preparations, it will not substitute for all on-board data processing requirements, and will of itself necessitate automated capability on shipboard for data formatting for transmission to the satellite. Therefore, we do not believe the desirability and utility of on-board data processing will become obsolete in the foreseeable future. (See Chapter V-Recommendations which Apply to Several Agencies and TDP-NAVOCEANO and C&GS.)

Recommendation: Consider for development the following new products which are described in Chapter IV:

- Sea-air energy exchange forecasts
- Subsurface current forecasts
- Upwelling forecasts
- Sea surface water level forecasts
- Inland Lakes ice forecasts
- Sea-air energy exchange atlases
- Surface water mass transport atlases
- Salinity atlases
- Bottom temperature atlases
- Water quality (pollution) maps and atlases

STUDY APPROACH

The Phase II study was conducted in four parts:

I. Analysis of the Needs of Data Service Customers

II. Delineation of Marine Data and Products and the Analysis of Selected Data Services

III. Analysis of Data Functions

IV. National Data Program for the Marine Environment

A description of the Objectives, Scope, Approach, Methodology and Product of each part of the study is described in the following sections. References to the applicable sections of progress reports and the Final Report are keyed to the discussion of the study approach.

<u>Part I Study</u> -- Analysis of the Needs of Data Service Customers

1. Objectives

The objectives of the Part I Study were to:

- Identify data producers and user communities and estimate the size of each. (Chapter II, Part I Report)

- Classify the user community in terms of data needs and use.

Some of the determinants of classes of data use are the following: purpose of data use; data type; frequency; volume, format, geography, quality, sample size, etc.; time requirements for data acquisition, transmission and retrieval. (Chapters IV and V, Part I Report; Chapter III, Volume One, Final Report)

- Evaluate the validity of stated needs. (Chapter II and Chapter III, Part II Report; Chapter IV, Volume One, Final Report)

- Determine the adequacy of existing data products and services to meet user needs. (Chapter IV, Part I Report; Chapter IV, Volume One, Final Report)

- Establish the need for new or improved data products or services in advancing toward marine science goals. (Chapter IV, Part I Report; Chapters II and III, Part II Report; Chapter IV, Volume One, Final Report)

- Estimate data acquisition and data service costs and describe benefits derived. (Chapter VI, Volume One, Final Report; Chapter IV, Volume Two, Final Report)

- Identify priorities among stated needs. (Chapters II and III, Part II Report and Chapter IV, Volume One, Final Report)

- Identify and illustrate the nature of data flow from diverse producers to a variety of data users. (Chapter III, Part I Report; Chapter II, Volume One, Final Report)

2. Approach

The following specific identifiable user categories and representative data applications were considered:

Category	Representative Applications
1. Environmental Forecasting	Preparation of:
	. marine weather and storm warnings
	. wave and sea ice predictions
	. coastal surf and current predictions
	. tsunami and storm surge warnings
	. estuarine flushing pr[illegible]ctions

2. Environmental Description	. mapping and charting . geophysical surveys . geological surveys . oceanographic surveys
3. Naval Operations	. safe navigation in coastal waters . avoidance of storms and other hazards to safety at sea . enhance performance of antisubmarine, undersea and mine warfare systems . optimize deployment of naval forces
4. Transportation	. safe navigation in coastal waters . avoidance of storms and other hazards at sea . optimize track selection to reduce cargo damage and economize on operational costs . transportation planning
5. Ocean Engineering	Design and development of: . coastal facilities, including harbors, sea walls and breakwaters . offshore towers and oil drilling platforms . ships and submersibles . improved fishing gear, including aquaculture technology . ocean systems and equipment . coastal desalinization and power plants . waste facilities . operation of submersibles . installation of undersea pipelines and cables . salvage operations . offshore oil and mineral production

6.	Industrial Operations	. industrial and operating decisions for offshore mineral and energy resources development, coastal development, etc.
7.	Fishing	. safe navigation in coastal waters . deployment of fishing fleets . avoidance of storms and other hazards at sea . optimize fishing location to increase yield per unit effort
8.	Federal, State and Regional Planning and Management	. enhancing water quality in the coastal zone and Great Lakes . aid in establishing Federal/State conservation and regulatory policies . facilitate planning for rational coastal zone use
9.	Research	Research in: . physical oceanography . biological oceanography . chemical oceanography . marine geology and geophysics . air sea interaction
10.	Public at Large	. safe navigation of pleasure craft in coastal waters . timely warning of storms and high waves . swimming conditions along coastal beaches
11.	World and National Data Centers	. storage, processing and dissemination of data at national centers

3. Research Methodology

The research in Part I was conducted in the form of a survey of known producers and users of marine data. The individuals and organizations which were contacted during Phase I; Phase II, Part I and Part II are listed in Appendix A. The number of interviews conducted in each of the user/producer communities is as follows:

User/Producer Community		Number of Interviews
Environmental Forecasting		56
Environmental Description		66
Naval Operations		49
Transportation		46
Ocean Engineering		53
Industrial Operations		77
Fishing		80
Federal, State and Regional Planning and Management		46
Research		126
Public at Large		13
World and National Data Centers		18
	Total	630

The definition of user communities follows:

1. Environmental Forecasting

ESSA Weather Bureau and Naval Weather Service Forecasters at local (WB Office and Fleet Weather Centrals) and national (FNWC, NMC, NESC), levels.

2. Environmental Description

Federal agency representatives in marine mapping and charting, geological and geophysical survey and oceanographic survey activities.

3. Naval Operations

Individuals aboard ship and on shore concerned with the planning and execution of naval operations.

4. Transportation

Merchant shipping companies, U.S. Coast Guard and U.S. Maritime Administration.

5. Ocean Engineering

Individuals concerned with the planning, design and installation of ocean and coastal structures and vehicles in the U.S. Navy, Army Corps of Engineers, BCF Exploratory Gear Laboratories, and ocean engineers in private industry.

6. Industrial Operations

Oil and gas, geological and geophysical survey, and marine cable laying companies.

7. Fishing

Commercial fishing organizations, processors, distributors, fishery resource managers and fishery scientists (included in the Research category).

8. Federal, State and Regional Planning and Management

State marine resource planners and managers; State and local water resource and water quality managers; Federal water pollution officials.

9. Research

Scientists in universities, naval laboratories, and Government research agencies (e.g., BCF Laboratories).

10. Public at Large

Representatives of boating associations; proprietors of acquatic stores; marine conservation and recreation organizations.

11. World and National Data Centers

Directors and employees of world and national data centers.

Owing to the extent and detail of marine data activities, this survey was conducted by means of personal interviews with individuals in the categories identified above. An example of a completed interview guide is shown in Appendix B. In no case was the interview guide mailed to an individual, although in some cases it was left with an individual for completion of some section(s) which required collection of additional information from within his organization.

It was important that the persons interviewed not simply be spokesmen for their organizations, but that they also be personally involved in the acquisition, processing, or use of marine data. Thus, while the respondents were identified by virtue of their organizational involvement in marine data affairs, interviews represented the expert opinion of knowledgeable men.

Interview data were aggregated, analyzed, and interpreted to determine present and probable future characteristics of the marine data user population. Adequacies and deficiencies in current data service and the extent of user satisfaction were identified. Institutional and international exchange relationships were examined. (Chapter IV, Part I Report).

In addition to standard data derived during interviews, respondents were asked to illuminate the operation of the present marine data network with a data flow description of a specific marine data activity in which they had been or are personally involved. The intent of these data flow descriptions is to identify the nature of marine data flow from original acquisition through various processing channels to end-use. (Chapter III, Part I Report; Chapter II, Vol. One,

Final Report). It is to be emphasized that these data flow descriptions represent the perspective of the interviewees, and that no judgement of completeness or validity in all areas is implied.

While the selection of the subject-matter of the data flow descriptions did, to a large extent, depend on the interviewees, attention was given to the areas of activity listed below. In these cases the data flow descriptions attempt to include such information as: description of data; original and proximate source of data to the interviewee; processing performed prior to its availability to the interviewee (where, by whom, for how long, etc.); ease and regularity of access; adequacy, relevance and value to the interviewee; quality; timeliness; cost of acquisition; processing by the interviewee and his end-use or output from the data; interviewee's projected future needs and recommendations for improved data services.

1. Ocean observation and prediction activities, especially as these bear on more accurate and longer range marine and continental weather predictions.
2. Map and chart production services as performed by the U.S. Navy, Coast and Geodetic Survey, and the U.S. Geological Survey.
3. Academic research activities of marine scientists in the effort to gain new knowledge and understanding about the oceans and their processes, especially as these are influenced by new technology, disciplinary and research goals.
4. The use of foreign data by U.S. marine scientists. The role of World Data Center A.
5. Usefulness of small craft charts prepared by the Coast and Geodetic Survey for recreational sailors and sports fishermen.
6. Environmental services forecasts prepared by the Bureau of Commercial Fisheries for west coast fisheries.
7. Marine engineering data used for the design, testing and operation of both military and civilian submersibles.

8. Marine engineering data used in offshore platform construction, e.g., for oil drilling.
9. Coastal warning services, especially of devastating storms, tsunamis and storm surges.
10. Marine weather, storm and wave forecasts, including forecasts for the Great Lakes, especially as used for recreational sailing, sport fishing, commercial fishing and offshore tower and drilling operations.
11. U.S. Merchant Marine services and products provided by the U.S. Navy, including nautical charts, sailing directions, pilot charts, etc.
12. Ship track routing services used by both merchant and U.S. Navy ships to avoid storms and reduce transit time.
13. Research and publications of marine scientists.
14. Regulatory and conservation programs related to water quality and marine resources, as practiced by Federal, State and municipal planners.
15. Marine environment resource development activities of oil and mineral industries, especially in regard to data products services provided by the Federal Government.
16. Sea ice forecasting services supporting ice area operations of U.S. shipping, Coast Guard and Navy.
17. Beach and surf forecasts provided by ESSA in the Los Angeles area.
18. Publications by BCF of the "faunal atlas" series summarizing knowledge in marine biological exploration and research.
19. Marine data activities in the U.S. Navy supporting the design, development, test, evaluation and operation of military systems and the deployment of naval forces.
20. Operations and functions of marine and marine-related data centers: National Oceanographic Data Center; Great Lakes Data Center; National Weather Records Center; Smithsonian Oceanographic Sorting Center; gravity and magnetic data centers.
21. Sea search and rescue services provided by the Coast Guard.
22. Marine taxonomy, especially the collection and processing of specimens.
23. ESSA's mapping and charting program activities.

4. Product

The product of Part I was the Part I Progress Report and Appendices.

Part II. Delineation of Marine Data and the Analysis of Selected Data Service

1. Objective

The objective of Part II was to delineate those marine data, data products, and services whose management requires priority attention at the national level; and to establish needed baseline information on data service operations, including an inventory of data resources and service capabilities. This objective was fulfilled by a consideration of current and projected marine data and data products, their relevance to national goals, and the adequacy of their processing as currently performed by established organizations, agencies and centers. (Chapters II, III and IV, Part II Report)

2. Scope

Part I of the study produced a catalog of marine data and data products for which needs exist. Part II evaluated these data and products to identify a critical subset in terms of breadth or priority of demand, relevance to national goals, etc. The current and projected availability of these data and the service operations performed on them was thus more precisely defined and the current adequacy of service operations as performed by various organizations, agencies, and centers was assessed.

3. Approach

The approach to Part II was directed to two major substantive areas: data and services.

a. <u>Data</u>

Designation of the marine data and data products of relevance to the achievement of national goals to be included within the scope of further study. This designation includes:

- Description of the kinds, forms, coverage, etc., of marine data, data products and services characterized by broad demand, priority need and strong relevance to national goals. (Chapter III, Part II Report; Chapter III, Volume One, Final Report)
- Inventory of data currently available in various categories designated above with respect to their source, quality, and benefit of use. (Chapter IV, Part II Report; Chapter III, Volume One, Final Report)
- Account of expected extent and use of data to be generated by new sensors and technology. (Chapters II and III, Part III Report; Chapter III, Volume One, Final Report; Chapter IV, Volume Two, Final Report)
- Estimates of current and projected amount of data of various kinds and from various sources, rates of accumulation, and rates of possible obsolescence. (Chapter III, Volume One, Final Report)

Based upon the results of Part I and the above descriptions, unfulfilled data needs were identified. Such circumstances proved to be the result of any one or several of the following: data are not being collected; needed data processing services have not been developed or activated; data are collected but are not available to all who require them; data availability may be restricted by industrial proprietary controls; data usage may be restricted by security classification controls; data move too slowly through the marine data network; data are incompatible in time, space, quality, or storage media; data are unavailable in useful form.

A rationale was given for excluding any categories of data that are not regarded as appropriate for subsequent study. (Chapter III, Part II Report)

b. Services

An inventory of organizations that currently perform service functions on marine data was made and their processing activities described. Such organizations include those major ones which process for publication or store for retrieval marine data designated in section 3a above. The form and extent of required coordination of data-related functions and services was evaluated. State, local and private service organizations were sampled selectively to assess possible means for obtaining increased access to their data holdings. The following aspects of these services were emphasized:

(1) Affiliations, sponsors, suppliers, and customers (users).

(2) Nature and size of data collections, including sources of data input, services offered, assessment of coverage, and areas of overlap.

(3) Degree and kinds of existing arrangements for coordination, data exchange and cooperation on domestic and international levels.

(4) Extent and practicality of expanded cooperative arrangements with domestic sources and users of marine data, such as State and local governments and private organizations. (Chapter IV, Part II Report, for items (1), (2), (3), and (4).

(5) Adequacy of services, facilities, and potential for growth. (Chapter IV, Part II Report; Chapter IV, Volume Two, Final Report)

(6) Cost analysis of major service operations. (Chapter VI, Volume One, Final Report; Chapter IV, Volume Two, Final Report)

4. Methodology

a. To achieve the objectives stated, a threshold criterion was established, depending on the character of data, purposes and benefits of data use, service requirements, and cost factors, which facilitate

a delineation of priority data and products. Several future funding levels for marine data management operations were hypothesized in order to provide planning options. (Chapter VI, Volume One, Final Report; Chapter IV, Volume Two, Final Report.) Similarly, an analysis was performed of marine information service operations to assess the relative importance of existing service agencies; to identify service agencies whose capabilities must be upgraded to meet current and projected demands; and to indicate changes that will create more effective operational facilities. (Chapter IV, Part II Report; Chapter IV, Volume Two, Final Report)

b. The determination of user data needs made in Part I was used in Part II to delineate the priority data and data products whose management, or the coordination of whose management, appears to be properly placed at the national level. Criteria were established, such as character, value and importance of the data, number of users, criticality of the data need, economic benefit of data use, etc., for identifying data and data products appropriate for national concern. These data and data products are called priority data and data products. The methodology employed for the selection of priority data and products was originally presented in Chapters II and III of the Part II Progress Report. The explanation of the methodology has been expanded in Chapter IV, Volume One, of the Final Report. Several examples of the work sheets which were used in the analysis for the selection of priority data and products are contained in Appendix D. These include work sheets for environmental description products, environmental forecasting products, and data.

c. An inventory was made of those marine information service agencies and data centers concerned with collecting and processing primary data on a regular and acknowledged basis in order to determine which existing data collection and processing activities should be

part of a national program. Criteria which were used for including data services in the national program are: size, quality and coverage of the data collection, quality and timeliness of data accession; and type, volume and cost factors of primary data products produced. (Chapter IV, Part II Report)

d. A cost feasibility study was conducted in order to determine which marine data products and services should be upgraded or expanded as part of a national program. The cost feasibility of upgrading primary data and services in a national program was determined by examining agency costs and budgets available. Gross agency costs were allocated to data product costs and compared with user benefits derived from data products. (Chapter VI, Volume One, Final Report; Chapter IV, Volume Two, Final Report)

e. Selective visits were made to some, but not necessarily all, of the organizations performing service functions on marine data in order to assure completeness and correctness of understanding of their processing activities on the categories of primary data. Such visits took the form of personal interviews and also involved the use of data collection forms. An example of a completed data collection form used in the Part II study is contained in Appendix C.

5. Products

The results of the Part II Study were presented in the Part II Progress Report.

Part III. Evaluation of Data Functions

1. Objective

The objective of Part III was to assess the degree to which contemporary and evolving technology, including hardware, procedures and methodology, is being applied within the existing and planned marine data network. Attention was given to specific features of operations which could be amplified and/or modified within the current or prospective state of the art for the purpose of increasing the efficiency and effectiveness of this network.

2. Scope

Marine data and data products delineated in Part II for priority consideration constituted the focus for Part III. In connection with specific data functions described below, the study investigated sources of current inadequacies, achievable standards of performance, and opportunities for significant improvements. Consideration was given, but not necessarily limited to, those marine data service organizations, facilities and centers visited and/or described in the Part II study and for which needed improvements in data service operations had been identified.

3. Approach

The approach to Part III was directed to eight major functions involved in the operation of the marine data network.

a. With respect to the technology of data handling, the study covered historic, contemporary and future collections, and considered four primary points: <u>Platform processing</u>; <u>data communications</u>; <u>land-based processing before data are deposited with a service agency</u>; <u>(and processing performed at service agencies)</u>. The principal

technological developments related to the handling of marine data were identified, and the opportunities for their improvement were appraised. The study focussed on the following:

(1) Automated Equipment Utilization. Some facets of marine data handling appear archaic in light of developments in automated electronic and mechanical devices and computer technology for collection, identification, storage, retrieval and publication. Therefore, automated equipment utilization was considered both integrally with the collection of priority data and their processing, as well as subsequent thereto. Of particular interest was the employment of better and more economical services either by means of parallel processing of marine data or through computers operated on a sequential time-shared basis; data processing by on-board computers; use of analog-to-digital converters; use of random access mass storage; graphic displays; and automated chart preparation. (Part III Report; Chapter V, Volume One, Final Report; Chapter IV, Volume Two, Final Report)

(2) Data Communications. Data communication systems and techniques that provide for the transmission of data from collection points to processing and storage facilities were investigated. Communication systems that transmit data between service agencies were also studied. (Chapter III, Part III Report; Chapter V, Volume One, Final Report; Chapter IV, Volume Two, Final Report)

(3) Media and Data Codes. (Chapter III, Part III Report)

(4) Inventory Accountability. There does not now exist a comprehensive national marine data inventory. Techniques for treating and maintaining an account of marine data which are accumulated were recommended. (Chapter IV, Part III Report; Executive summary, Final Report; Chapter IV, Volume Two, Final Report)

(c) Accessibility. Functional requirements for access to marine data holdings were identified. (Chapter IV, Volume Two, Final Report)

(d) Quality Control. Requirements for quality control of marine data included consideration of instrumentation reliability, consistency of sampling design, and control of post-observation manipulation. (Chapter II, Part III Report)

(e) Dissemination. Dissemination of marine data and data products was investigated to assess the adequacy of existing dissemination methods in comparison with the state of the art offering alternative or additional techniques. (Chapter IV, Volume Two, Final Report)

(f) Input Structure. Consideration was given to the requirement for for establishing standards controlling the input structure of marine data. (Chapter II, Part III Report)

(g) Archival Storage. Functional requirements for archival storage of marine data and data products were based on an assessment of current storage methods and retrieval services. (Chapter IV, Volume Two, Final Report).

(h) Data Analysis. Requirements pertaining to data analysis refer to the methods employed by centers and their customers interactively for analyzing, reducing and packaging marine data to make them more generally usable and useful. (Chapter IV, Part III Report; Chapter IV, Volume Two, Final Report)

4. Methodology

Performance of Part III was primarily an analytic effort augmented by selective interviews with appropriate technical experts. Emphasis was placed on identifying the functional requirements and establishing the technical feasibility of fulfilling them.

5. Product

The product of Part III was the Part III Progress Report.

Part IV. National Data Program for the Marine Environment

1. Objective

The objective was to prepare a Final Report of the Phase II study. The Final Report consists of the following: a set of recommendations to he Marine Sciences Council regarding desired Federal initiatives to upgrade the effectiveness of the marine data network, covering all phases of marine data management including planning, acquisition, processing, storage and end-use; appraisal of current marine data networks, marine data requirements; delineation of priority data and products; requirements and input of technological change on marine data management; evaluation of alternatives for improved data management; a recommended Technical Development Plan (TDP) which proposes specific time-phased actions by designated agencies, requiring both short- and long-term implementation to ten years, that will result in the desired improvement in the operation and usefulness of the marine data network.

2. Scope

Technical analyses conducted during preceding and final parts of the Phase II study form the basis for comprehensive recommendations for Federal action to strengthen marine data management activities. The emphasis in the TDP is to build on existing capabilities to enhance the effectiveness of the marine data network and thus facilitate the achievement of desired goals of improved data flow and the scope, quality, and timeliness of marine data services and products.

3. Approach

a. The Final Report analyzes requirements and specifies functions required for planning and coordination within the national marine data

management program. The report includes statements of the requirements for data, identifying users, purposes, and benefits and alternative means for satisfying requirements, and the advantages and disadvantages of each. Consideration is given to the need and mechanism for coordinating marine data activities at the Federal level.

b. The Technical Development Plan presents recommended priorities, criteria for determining priorities, and schedules for implementation, as well as estimates of the resources necessary to implement the plan, including personnel, equipment and funds. Options of the plan are developed based on alternative levels of assumed Federal funding. Recommended improvements to the marine data operations of the several agencies designated in the Technical Development Plan fall into any of the following broad categories:

1) Introduction of available techniques and technology in order to update current operations, affecting both products and services, in the measurement and sampling of the marine environment, in the quality control, analysis, reduction and storage of data, and in retrieving and disseminating data to the user community.

2) Identification of promising opportunities for improvements in data functions that show prospects of yielding to new techniques and technology under development within the next ten years.

3) Improvements in the data acquisition process--e.g., multiple use of data acquisition networks.

4) Modification or expansion of existing and proposed data handling activities and data service facilities in order to make their services more complete, responsive, timely, and of higher quality, including the elimination of unnecessary obstructions to data access and flow, particularly in the case of proprietary data.

(5) Development of new data service activities where needed.

(6) Increasing the com cibility of marine data and data products at all levels, from data definitions (e.g., units of measurement) to intersystem formats, media and displays.

(7) The exercise of Federal responsibility in monitoring the performance of agencies within the national marine data network, and in assuring appropriate coordination with internat nal and non-Federal domestic organizations engaged in the acquisition, processing, storage and dissemination of marine data.

4. Methodology

A benefit/performance/cost analysis has been made for options of the Technical Development Plan. Factors which are considered in the benefit/performance/cost analysis are:

a. Potential benefits in relation to development and implementation costs.
b. Scope and intensity of validated needs for data, products and services.
c. Trade-offs among technical development plan options.
d. The impact of technological development on the cost of data service operations in the next decade.

5. Product

The Final Report consists of two volumes: Volume One, National Data Program for the Marine Environment, and Volume Two, Technical Development Plan.

I. ORIGIN AND STATEMENT OF THE PROBLEM

INTRODUCTION

The purpose of this chapter is to introduce the reader to basic, contemporary concepts regarding national information networks; establish a perspective for the evolving national interest in marine data management problems; and trace the evolution of the present study. A decade ago, the importance and feasibility of integrating data--and information-handling systems into organized, articulated form was virtually ignored. Even today, the problem is often thought to be principally a matter for organizational solution. Indeed, organizational issues are not trivial, but technology is not the child of organization. It is capable of adapting to a wide variety of organizational configurations. More to the point, technology has an intrinsic compelling appeal for application. The last ten years have witnessed the continuing development of information systems technology to the point where it offers realistic solutions to the management of scientific and technical information in many fields--and it is being applied to this end in some few. It is no longer visionary to conceive of its application in any field, including the marine sciences. A crucial part of the entire marine sciences program is that of data management. For in this, as in such areas as medicine, education, space exploration, and peaceful application of nuclear science, husbandry of data must be accomplished to assure maximum exploitation of available data by the widest possible audience.

NATIONAL INFORMATION NETWORKS

The intellectual concept of national information networks based upon the tools and techniques of automation may be said to have begun with Vannevar

Bush's article, "As We May Think" which appeared in the Atlantic Monthly, July, 1945. However, the active concern of the scientific establishment in the Executive Office of the President with the management of scientific and technical information dates effectively from 1958. In that year, the President's Scientific Advisory Committee (PSAC) formed a panel chaired by W. O. Baker to report on "Improving the Availability of Scientific and Technical Information in the United States." Recommendations contained in this report were instrumental in the creation of the National Science Foundation's Office of Science Information Services. Another PSAC panel was constituted in 1962, under the chairmanship of A. M. Weinberg, to analyze broad responsibilities of the technical community and the government in the handling of scientific and technical information. The Weinberg Report, "Science, Government, and Information," was published in January, 1963, and includes a large number of recommendations to the technical community and to government agencies concerning future actions to improve the communication of scientific and technical information. In the words of the report, its "major findings and recommendations" are that "the working scientist must share many of the burdens that have traditionally been carried by the professional documentalist. The technical community generally must devote a larger share than heretofore of its time and resources to the discriminating management of the ever-increasing technical record. Doing less will lead to fragmented and ineffective science and technology." It asks that "each federal agency concerned with science and technology...accept its responsibility for information activities in relevant fields, and...devote an appreciable fraction of its talent and other resources to the support of information activities."

Concurrently, a task force appointed by the President's Special Assistant for Science and Technology, under the chairmanship of J. H. Crawford, focused more specifically on arrangements within the government itself. This report, "Scientific and Technological Communication in the Government: Task Force Report to the President's Special Assistant for Science and Technology," was issued in April, 1962. This report suggested reorganization and reorientation

of information management within government, with emphasis on leadership, policy formulation, and support from the executive branch. It also recommended that each research and development agency set up an office to provide agency-wide direction and control of information activities.

Also in 1962, the Federal Council for Science and Technology created the Committee for Scientific Information under the auspices of the Office of Science and Technology, Executive Office of the President. In 1964, the name of the committee was changed to Committee on Scientific and Technical Information (COSATI) to indicate that its scope of interest included both technical and scientific information activities. The objectives of this committee are:

1. To develop among the executive agencies of the government a coordinated but decentralized scientific information system for professional users.

2. To cooperate with non-government agencies in the coordinated development of scientific and technical information systems of national character.

3. To recommend standard, methodology and systems, as well as new programs--especially experimental ones.

4. To identify and recommend assignments of responsibility among federal agencies and to review resources assigned to agency programs.

5. To facilitate inter-agency coordination at management levels and to recommend management policies and procedures for agency information activities.

In addition to standing panels, the committee has created task forces for specific purposes. One of these is the COSATI Task Group on National Systems for Scientific and Technical Information, formed in the fall of 1964 at the request of the President's Special Assistant for Science and Technology. Task

group assignments have been to (a) inventory and evaluate the resources currently committed to U.S. scientific and technical information activities as well as to determine the requirements of various user communities, and (b) recommend plans for the systemization of the national aggregate activities which provide guidance for both government and the private sector.

COSATI has initiated and directed several study contracts on national systems, two of which are especially noteworthy: National Document-Handling Systems for Science and Technology; System Development Corporation, John Wiley and Sons, Inc., New York, 1967; and Study of Scientific and Technical Data Activities in the United States; Science Communication, Inc., Clearinghouse for Federal Scientific and Technical Information, AD-670606,7,8, 1968. Both reports describe deficiencies in the existing national information network with respect to document-handling and data-handling, respectively, and reccomend a variety of federal initiatives and system configuration proposals to overcome these deficiencies. The second report is perhaps the only national study addressed to the handling of data per se, rather than derivations therefrom, such as abstracts, documents, conferences, etc.

The National Science Foundation Act of 1950, established, authorized, and directed the Foundation "to foster the interchange of scientific information among scientists in the U.S. and in foreign countries." Upon passage of the National Defense Education Act of 1958, the Foundation was additionally directed "to provide, or arrange for the provision of, indexing, abstracting, translating, and other services leading to a more effective dissemination of scientific information" and "to undertake programs to develop new or improved methods, including mechanized systems, for making scientific information available." The Act also charters the Scientific Information Council as an advisory group to the Office of Science Information Services, created to supersede the former Office of Scientific Information. In 1964, the Office of Science and Technology, Executive Office of the President, assumed responsibility for leadership and coordination among government agencies, including

the NSF, while NSF retained responsibility for the non-federal scientific community in regard to the husbandry of scientific and technical information, both for its own and the government's purposes.

Among the many activities to which NSF either contributes or provides full financial support, specific mention should be made of the Committee on Scientific and Technical Communication (SATCOM), created jointly by the National Academy of Sciences and the National Academy of Engineering. Established in 1966, SATCOM is completing its final report which will analyze the broad spectrum of national scientific and technical information networks and recommend courses of action for both the Federal and private sectors to enhance the utility of these networks.

The National Science Foundation is also the principal funding agency for the Science Information Exchange (SIE), operated by the Smithsonian Institution. The SIE receives, organizes and disseminates information about current scientific research. Its basic mission is to provide information for planning and managing research activities, whether they are government or non-government supported, before such information might otherwise be available. It promotes the exchange of information concerning current research, focusing on the pre-publication phase, to compensate for the gap between the time a research project is initiated and the time its results become generally available in a publication. In 1967, over 122,000 records of research projects, planned or in progress, were registered with SIE; of this total, some 2,000 were directly concerned with the marine sciences.

Although necessarily restricting its consideration to library services, mention should be made of the President's Committee on Libraries and the related National Advisory Commission on Libraries. Established by Executive Order in 1966, the Commission was charged, among other things, to:

> "Make a comprehensive study and appraisal of the role of libraries as resources for scholarly pursuits as centers for the dissemination of knowledge, and as components of the evolving national information systems."

Under the chairmanship of Douglas M. Knight, the Commission's report was submitted in July, 1968, and includes in its recommendations substantially increased federal responsibility for establishing policy and for the creation of permanent federal offices for planning and for technological research on library and information science in all its aspects.

The international community, through the mechanism of the United Nations, has recently become active in addressing the problem of scientific and technical information exchange. Operating under the joint auspices of the United Nations and UNESCO, the International Council of Scientific Unions (ICSU) became operable in 1967 for the purpose of promoting the formation of advisory groups in the twelve international scientific unions and six member countries composing the Committee. In addition to the Science Information Exchange described above, the Smithsonian Institution also operates the International Exchange Service (IES), which is the focal point in the federal sector for the exchange of documents with other countries in accordance with established agreements between the nations concerned.

The record of attention and effort devoted to the problem of scientific and technical information exchange, both nationally and internationally, could be expanded many times. It has been the purpose of this review simply to identify highlights of this effort, and to suggest that the momentum observed within the last decade is increasing and can be predicted to increase in the future. On signing the Public Broadcasting Act of 1967, for example, then President Lyndon Johnson stated:

> "I believe the time has come to stake another claim in the name of all the people, stake a claim based upon the combined resources of communications. I believe the time has come to enlist the computer and the satellite, as well as television and radio and to enlist them in the cause of education.... We must consider new ways to build a great network for knowledge--not just a broadcast system, but one that employs every means of sending and storing information that the individual can use... such a system could involve other nations, too--it could involve a partnership to share knowledge and thus to enrich all mankind."

PERSPECTIVE OF MARINE DATA MANAGEMENT

In the context of increased attention and momentum to the creation of national and international information networks, recognition has been given, and actions undertaken, with respect to the specialized problems of discipline--oriented and applications-oriented data management. In the case of the former, the establishment of a national network of biomedical information, under the auspices of the National Library of Medicine, is an outstanding example. Another example is the creation of Educational Resources Information Centers under the sponsorship of the U.S. Office of Education. In the non-federal sector, professional societies, such as the American Institute of Physics and the American Chemical Society, have frequently taken an aggressive lead in establishing advanced systems for data and information exchange. In the case of applications-oriented data management, the National Aeronautics and Space Administration (NASA) and the Atomic Energy Commission (AEC) have been active in establishing systems for the broadest possible dissemination of data and information to the scientific and technical community. It is noteworthy that each of these agencies was specifically charged with this responsibility in its respective enabling legislation.

The marine sciences community has never had the direction and monetary support enabling it to develop a well organized and articulated system for managing marine data. Producers and users of marine data now include more than 30 bureaus in 15 federal departments and agencies; 30 coastal and Great Lakes State governments concerned with developing and regulating the use of marine resources; 250 federal, state, academic and private laboratories involved in marine research; 1,100 U.S. flag merchant ships; 100,000 commercial fishermen; several million sport fishermen; tens of thousands of marine data users in oil and other industrial firms; tens of millions of recreational swimmers, fishermen, and boaters in the coastal and Great Lakes States; and more than 7,000 scientists, engineers, specialists, technicians, and others engaged in marine research and development activities. Collecting, processing,

and distributing marine environmental data within this community have been performed within a complex, loosely structured framework which has evolved over time in response to a variety of separate and sometimes unique requirements.

Recognition of the inefficiencies in the management of marine sciences data has not been lacking. During the 1960's, indeed, three of the four generally acknowledged national marine data centers were established: National Oceanographic Data Center (NODC) in 1961; Smithsonian Oceanographic Sorting Center (SOSC) in 1963; and the Great Lakes Regional Data Center, operating within the U.S. Lake Survey of the Corps of Engineers, in 1964. The fourth national data center, National Weather Records Center (NWRC), had been established in 1951 and was assigned to the Environmental Science Services Administration (ESSA) upon its formation in 1965.

In 1966, the Congress enacted the "Marine Resources and Engineering Development Act of 1966," (Public Law 89-454) "to provide for a comprehensive, long-range and coordinated national program in marine science, to establish a National Council on Marine Resources and Engineering Development, and a Commission on Marine Science, Engineering and Resources..." Both the Council and the Commission were charged to contribute to the objective of "the effective utilization of the scientific and engineering resources of the nation, with close cooperation among all interested agencies, public and private, in order to avoid unnecessary duplication of effort, facilities, and equipment...."

Under the chairmanship of Julius A. Stratton, the Commission issued its report in January, 1969. In addition to a principal recommendation for reorganization of many federal government marine-related agencies into a new agency, the Commission Report contains the observation that:

> "All users of the sea and the scientific community look to the federal government to establish and maintain appropriate data centers for the storage, retrieval, and dissemination of such

data.... There is no coordinated system of data centers for storing and retrieving oceanographic data. Unless such a system can be established quickly, the agencies literally may be overwhelmed by the volumes of new data generated by expanded research programs and the increased use of continuous sensing and recording devices...."

The report states that the funding for three of the national data centers is inadequate and recommends that "the National Oceanographic Data Center, the National Weather Records Center, and the Smithsonian Oceanographic Sorting Center be adequately supported to enable them to keep up with the growing volume of marine data and to take advantage of modern storage and retrieval technology."

Dealing even more broadly with the problem of marine data management, the President, in his first annual marine science report to the Congress, "Marine Science Affairs--A Year of Transition," February, 1967, noted the following:

1) "Studies have shown evidence of previous deficiencies in the Nation's marine data handling; delays in filing; archaic handling methods; lack of critical evaluation and inadequate identification of purpose."

2) "The exploration of the oceans has been a somewhat random and often uncoordinated process. There has never been widespread agreement among the marine science community, as there is in some other fields, as to data handling procedures and standards with the result that materials are not as coherent and systematic as we now desire. In the meantime, technology now makes it possible to accumulate data at a vastly faster rate."

3) "As the problems to be solved become more complex, global in scope, and multidisciplinary in content, the data consumers will be less able to produce their own raw materials and will become more dependent on the work of others. To prevent unnecessary and costly duplication in the data collection--the most costly part of marine sciences--collected data should be readily available to all users consistent with the need for national security."

The report states the objective that "any future system to improve the management of data should deal in one consistent way with data from its source through authentication, indexing, filing and retrieval. Such a system involves not only the data commodity itself, but intimately involves the variety of public and private users and contributors, the information handling organizations, and administrative and support activities. When we refer to a system, incidentally, we do not necessarily anticipate a centralized operation, but include the articulation of a number of specialized data centers appropriately linked and meeting quality standards." On the basis of this analysis of the urgent need for improvements in the handling of marine data, from initial acquisition through the various stages of processing, storage, retrieval and end-use, the National Council on Marine Resources and Engineering Development initiated a major study to develop a National Data Program for the Marine Environment. While the results of this study are to apply to national marine data management activities, it should be noted that these include U.S. involvement and desire to promote international marine data exchange. The International Council of Scientific Unions (ICSU) is a non-governmental organization, and includes nine scientific unions and scientific committees having an important interest in marine problems. Inter-governmental organizations within the United Nations system include the United Nations Education, Scientific and Cultural Organization (UNESCO), within which the Inter-governmental Oceanographic Commission (IOC) operates, and which has the responsibility for organizing the international exchange of oceanographic data through World Data Centers. The Commission has organized large cooperative investigations in the Indian Ocean, tropical Atlantic and western North Pacific, and is now organizing such work in the Caribbean and Mediterranean. The IOC has been designated to play a leading role in coordinating the International Decade of Ocean Exploration, proposed by the United States and adopted by resolution of the U.N. General Assembly in December, 1968. Other U.N. intergovernmental organizations bearing on the marine sciences are the Food and Agriculture Organization (FAO); the World Meteorological Organization (WMO), responsible for the development of the World Weather Program; the International Atomic

Energy Agency; the Inter-governmental Maritime Consultative Organization (IMCO); and the World Health Organization (WHO).

EVOLUTION OF NATIONAL MARINE DATA MANAGEMENT PROGRAM

The overall objective of the study initiated by the National Council on Marine Research and Engineering Development, referred to hereafter as the Marine Sciences Council, is to "identify, formulate, and evaluate requirements for information and data management in support of the endeavor to develop the full potential of the marine environment." This quotation, taken from the Request for Proposal issued by the Government in May, 1967, is consistent with the new initiatives recommended by the President in his first annual marine sciences report, and illustrates the broad scope of the study objectives. It implies the necessity to examine the application of marine data and data products in all significant areas, ranging from citizen recreation to naval operations. It clearly specifies the requirement to analyze the derivation and dissemination of marine data in all stages of processing, from initial acquisition to end-use.

The project has been conducted in two phases. The first phase was initiated in June, 1967, and was documented in a two-volume final report, "Phase I Final Report: National Data Program for the Marine Environment," published in December, 1967. The principal tasks of this phase were to: review prior studies; survey relevant literature; collate existing agency plans; and develop a Phase II plan. The focus of concentration was on federal government operations, but did not exclude state and local government activities, private institutions, commercial organizations, and international exchange.

The conclusion of this phase of the study was that a loosely-connected national marine data network does exist; whether it deserves to be called a system is probably a matter of individual taste. Prior surveys, studies, and plans have

identified shortcomings in the effective operation of this network and have made recommendations for system improvements. Among the shortcomings noted by the report of the Council's Phase I study were the following:

1. Lack of a central index or directory of national marine data sources and services;

2. Lack of coordinated planning, programming, and budgeting capability to assure orderly evolution of the national marine data network;

3. Absence of a mechanism for "load-balancing" at the national level to match data management capabilities against major program requirements;

4. Absence of a central index of legislation and policy relating to the U.S. position regarding the ocean and its exploitation;

5. No unified incentive structure to motivate either organizations or individuals to cooperate in improving the effectiveness of the overall marine data system.

The second phase of the study was initiated in March, 1969. Based on the findings of Phase I, coupled with corroborating sources, the Marine Sciences Council staff observed that marine data are not moving expeditiously from acquisition to end-product or to data centers equipped to make them rapidly accessible for use. Both increases in data traffic and changes in the character and quality of data resulting from new technology will impose additional problems of data management in the future. Advances in marine science depend critically upon the effective flow of information. The data commodity and related products and services must be shared more widely if the country is to achieve desired objectives in the ocean.

Phase II of the study was performed in a series of interrelated parts. These were:

Part 1: Analysis of the Needs of Marine Data Service Customers

Part 2: Delineation of Priority Marine Data and Products and the Analysis of Selected Data Services

Part 3: Analysis of Data Functions

Part 4: National Marine Data Prog a for the Marine Environment

The general conclusions reached by the Part I study are presented below. These conclusions were based on an interview survey of some 630 persons representing a sample of the principal producer/user communities described in Chapter II.

- There are general classes of marine data which are common to the needs of several user categories. Among these classes are forecasting data, survey or track-line data, ocean station data and coastal zone data. Not only do these classes of data serve multiple users, but they have distinctive short-term (e.g., environmental forecasting) and long-term (e.g., environmental description) values, and hence form a basis for projecting future requirements.

- Management of existing marine data resources is diffuse and fragmented. Today's marine data management system evolved without coordinated planning, but rather in response to requirements that were largely unrelated. Prospects are dim for the most effective use of these data under present policies and priorities.

- Our national supply of data has already outstripped our capacity to extract its maximum usefulness. Much of the existing data is not used simply because there are not plans or organizational

responsibilities to produce those products for which it s appropriate.

- Insufficient attention has been paid to the tailoring and human engineering of many marine data products, and in educating recipients in their use, to satisfy the needs of the constituency.

- We do not have adequate or uniform knowledge about the resour s and characteristics of the ocean environment. Compared to its use by man, for example, we know far less about the nearshore coastal zone than we know about the deep ocean.

- As a nation, we will become increasingly dependent on marine resources. There consequently must be an appropriate role and responsibility for the Federal government in the coordination of marine data management to assure the effectiveness with which these resources are developed and applied.

In Part 2, the problem was to delineate and describe certain priority marine data, data products, and data service operations. The term priority is meant to refer to data, products, and services which bear importantly on stated national goals, which were considered deficient in the survey of users' needs, and for which specific recommendations are to be made to improve their quality, timeliness and usefulness. Omission of a product from the priority class is not a measure of its intrinsic value, but rather signifies that upgrading is of lesser urgency than for those products included in the priority list. Also, the omission of a product from the priority class should not be interpreted as a recommendation of this study to decrease the present level of support provided to non-priority products. Indeed, it is recognized that each agency having responsibility for the furnishing of non-priority products will be alert to future changes in user needs in order to upgrade these products when necessary.

Table I-1 lists the environmental forecasting priority products.

TABLE I-1

FORECASTING PRIORITY PRODUCTS

Existing Forecasting Priority Products

- Hemispheric Weather charts (Analyses and Prognoses)
- Wave Height Forecasts
- Extended Range Weather Forecasts
- Coastal Weather/Wave Forecasts
- High Seas Weather Forecasts
- Storm Surge Advisories (Storm Tide Warning Bulletins)
- Tropical Cyclone Advisories
- Surf Forecasts
- Tsunami Warnings
- Products Obtained from Satellite Remote Sensors
- Sea Surface Temperature Charts
- Sea Ice Forecasts
- Domestic Ice Forecasts
- Thermal Structure Forecasts
- Estuarine Flushing Predictions
- Fishery Products Reports
- Fishery Advisories
- Fishery Abundance Forecasts

New Forecasting Priority Products

- Sea-Air Energy Exchange Forecasts
- Subsurface Current Forecasts
- Upwelling Forecasts
- Sea Surface Water Level Forecasts (Meterological Tides)
- Inland Lakes Ice Forecasts

Table I-2 lists the descriptive priority products.

TABLE I-2
DESCRIPTIVE PRIORITY PRODUCTS

Existing Descriptive Priority Products

Marine Historical Environmental Products*

- Climatological Atlases (including Historical Northern Hemisphere Daily Weather Map Series)
- Wave and Swell Charts
- Sea Surface Temperature Atlases and Charts
- Surface Current Charts
- Ice Atlases

Pilot Charts

Water Column Properties Data Products

- Ocean Station Atlases
- Thermocline Depth Charts
- Sound Velocity Atlases
- Sonar Range Charts

Marine Topographic Maps

- Bathymetric Maps and Charts
- Hydrographic Survey Smooth Sheets

Navigational Products

- Nautical Charts

*Tide Tables and Tidal Current Tables do not appear in this list because they were classified as non-priority products, i.e., they are critical products but significant unfulfilled needs do not exist for the standard, astronomical products. However, two new products, Sea Surface Water Level Forecasts and Mean Sea Level Atlases, have been recommended for providing forecasts and historical data on the meterological component of tides, supplementing the standard tide products.

TABLE I-2 (Cont'd.)
DESCRIPTIVE PRIORITY PRODUCTS

Geological and Geophysical Products

- Geological and Geophysical Reports
- Magnetic Field Maps
- Gravity Field Maps
- Geological Maps

Biological (Fishery) Products

- Fishery Statistics Reports
- Fishery Resource Atlases
- Sportfishing Atlases

Water Quality and Pollution Control Reports

New Descriptive Priority Products

- Sea-Air Energy Exchange Atlases
- Subsurface Current Atlases
- Mean Sea Level Atlases
- Coastal Atlases
- Great Lakes Climatological Atlases
- Surface Water Mass Transport Atlases
- Salinity Atlases
- Bottom Temperature Atlases
- Water Quality (Pollution) Maps and Atlases
- Ocean Engineering Reports

Table I-3 lists the priority marine data types which are required either for research or for the generation of priority products.

TABLE I-3
PRIORITY MARINE DATA TYPES

- Physical
- Chemical
- Geological & Geophysical
- Biological & Fishery
- Meteorological
- Pollution
- Engineering
- Other

  (Acoustics, Optics, Electromagnetics, Sea Ice, Biomedicine)

Table I-4 lists the agencies whose data service operations are concerned with the acquisition and processing of priority data, and/or the generation of priority products. In all, some 25 individual data service facilities were visited to assure adequate understanding of current methods of operation employed, and to learn of existing plans for data and product improvement.

TABLE I-4
DATA SERVICE ORGANIZATIONS VISITED

Bureau of Commercial Fisheries
U.S. Navy Bureau of Medicine
Bureau of Sport Fisheries and Wildlife
State of California
ESSA Coast and Geodetic Survey
U.S. Coast Guard Oceanographic Unit
Coastal Engineering Research Center
Federal Water Pollution Control Administration
Fleet Numerical Weather Central
U.S. Geological Survey
Great Lakes Regional Data Center
U.S. Lake Survey
NASA Earth Resources Applications Program
National Environmental Satellite Center
National Meteorological Center - ESSA Weather Bureau
National Oceanographic Data Center
National Weather Records Center - ESSA, Environmental Data Service
Naval Undersea Research and Development Center
Office of The Oceanographer of the Navy
U.S. Naval Oceanographic Office
U.S. Office of Naval Research
Scripps Institution of Oceanography
Smithsonian Oceanographic Sorting Center
ESSA Weather Bureau and Marine Forecast Units
World Data Center-A

From the analysis of these products and services, it was concluded that:

- Current marine data acquisition and product preparation is well supported by the needs of national objectives and constituent demand. If anything, the problem is that of mounting pressures for improvement in product utility beyond the resources and capacities of the service organizations;

- Within the limits of their resources, the service organizations are doing a good job; more often than not, they themselves recognize deficiencies in their operations, and have planned developmental programs to eliminate these deficiencies. Such programs are always contingent on the availability of personnel and funds and hence cannot be guaranteed until budget allocations are determined. The past years have not been favorable to the initiation of developmental projects within the marine data community;

- Lack of coordinated planning is in evidence both with respect to new product development and with respect to multiple access and use of available data and products;

Part 3 of the Phase II study addressed itself to the evaluation of various data functions involved in the processing of marine data and the generation and dissemination of marine data products, specifically, data acquisition, data inventory and accountability, data accessibility, quality control, dissemination, input format and sampling design, archival storage, and data analysis. The objective was to assess the degree to which contemporary and evolving technology, including hardware, procedures and methodology, is being applied within the existing and planned marine data network. General findings from this part of the study are:

- Active development is evident in instrumentation and systems for

marine data acquisition from shipboard, submersibles, buoys and fixed platforms, and both aircraft and spacecraft. The majority of marine data types will continue to be acquired by shipboard systems over the next ten years.

- On-board data processing is well established in the technology, but is not being sufficiently utilized. The advantages of on-board processing include immediate verification of data quality, the opportunity to adjust data sampling design in real time, on-board product generation, and the expeditious processing of data for transmission to shore-based facilities for later detailed analysis. More rapid outfitting of on-board processing capability for all survey ships is strongly recommended.

- Data communications from ocean stations, mobile or fixed, to shore-based facilities can be substantially satisfied by planned HF radio frequency facilities. Data exchange among shore-based national data centers is principally by mail today, but will probably evolve in the next decade toward automated computer linkages for which established technology is applicable.

- Data storage, retrieval, and dissemination functions are undergoing a transition from manual and mechanical systems to more sophisticated computer technology. Computer storage and retrieval of digital data is already commonplace, although major conceptual problems remain regarding the design of data file systems and conversion of backlog data. Computer storage of analog and imagery data is not as well advanced and may depend on new technology, expected within the decade, for general application. Product generation, e.g., maps, charts, and analytic reports, will benefit from recent and expected technological advances in automated graphics and photocomposition.

- Standards for data compatibility and quality control are not well established within the marine science community. This is a significant

problem area. Until such standards are developed, it is desirable that a report of the conditions of data collection, including instrumentation used and procedures employed, be incorporated as an integral part of the storage of the data in national centers.

Part 4 of the study consists of the Technical Development Plan (TDP), together with the final report of the entirety of Phase II. The TDP specifies a recommended implementation program for each marine data service organization and program, from Fiscal Year 1971-1980. Volume II of the final report elaborates the details of the recommended implementation program. A summary of the TDP is found in Chapter VII of this volume.

II. DESCRIPTION OF THE CURRENT MARINE DATA NETWORK

DATA AND DATA PRODUCT PRODUCERS

CATEGORIES OF PRODUCING AGENCIES

A marine data producing agency is defined as an organization involved directly or indirectly in data acquisition and dissemination, i.e., measurement or sampling, preliminary processing for transmission, transmission to one or several centers for further processing, storage, or archiving or direct dissemination to other data users. A data product producing agency is an organization that receives data from the data collector, collates and processes the data, prepares a product from combined data, and disseminates the product to the users. A third category includes data services that accumulate data for storage and retrieval, or archiving, but neither participate in the original collection of the data nor produce formal data products. A number of agencies are both data and data product producers, while several combine both of these functions with storage, retrieval, and archiving.

Producing agencies are categorized as (1) Federal; (2) regional, State, and local; (3) institutional and academic; (4) nonprofit; and (5) industrial. The producers of central interest in this report are the various Federal agencies; non-Federal agencies are described in varying detail, depending upon their overall importance to marine data user communities and the degree of their interactions with Federal agencies.

FEDERAL AGENCIES

Department of the Navy

Marine science data are produced by the Navy for various activities of the Naval Oceanographic Program. This program encompasses that body of science,

technology, engineering, and operations--and the personnel and facilities associated with each--essential to explore and lay the basis for exploitation of the oceans and their boundaries for naval operations, to enhance national security, and to support other national objectives. The Naval Oceanographic Program is the responsibility of the Oceanographer of the Navy, who reports directly to the Chief of Naval Operations. The exercise and direction of the program is through three Assistant Oceanographers and the Commander, Naval Oceanographic Office (NAVOCEANO), each of whom is responsible for one of the four major functional areas: Ocean Science, Ocean Engineering and Development, Oceanographic Operations, and Environmental Prediction Services.

The Naval Oceanographic Program is oriented toward providing the oceanographic information and related technical base to support defense missions, and is coordinated with the programs of other Federal agencies. Ninety percent of collected environmental data are unclassified and may be made available to the scientific and industrial communities. Efforts sponsored by the Navy in the marine sciences under various commands and at various naval, academic, and industrial locations have served to create a broad base of scientific and engineering competence that can be applied to problems affecting U.S. military requirements.

Ocean Science Program

The Ocean Science Program is managed by the Assistant Oceanographer of the Navy for Ocean Science, whose primary duty is Chief of Naval Research. The program encompasses the efforts in research, development, and technical guidance in support of operations necessary to advance the knowledge of the physical, chemical, biological, and geological nature of the world's oceans and their boundaries (surface, bottom). The program consists in that portion of the Naval Oceanographic Program that is largely scientific (or clearly in support of scientific inquiry) and all underwater acoustic research. It embraces a large number of scientific investigations that are worldwide in scope, broad

in disciplinary coverage, and concerned with the oceanographic environment from the bottom through the air-sea interaction zone. The largest segment of the Ocean Science Program is the contract research program administered by the Office of Naval Research (ONR). The objective of this program is to support and develop centers of excellence in the marine sciences in order to provide a broadly based body of knowledge that can be applied to a variety of Navy needs. This research is carried on at 18 major academic and private institutions, as well as by many individual investigators in the academic community on a smaller scale. To generate data in support of these research programs, the Navy supports, either wholly or in part, investigations from a total of 34 research vessels 65 feet in length or larger. In addition, investigators in the Ocean Science Program obtain data through the use of drifting ice stations, towers, aircraft, buoys, bottom habitats, and submersible research vessels.

Portions of the Ocean Science Program are also carried out by the Ocean Science Division of the Naval Research Laboratory and by the Research and Development Department of the Naval Oceanographic Office. To foster the exchange of information and the development of cooperative programs, these two organizations have been collocated with the Ocean Science and Technological Group of ONR, an arrangement that has been recently formalized as the Maury Center for Ocean Science of the Navy.

In addition to the above, ocean science programs are also carried out at Navy laboratories and contract research centers under the management of the Chief of Naval Material. Eleven such laboratories are involved in the program, the major objective of which is to bridge the gap between the basic research conducted by the academic community and the engineering projects associated with the development of specific equipments. Major program managers within the Navy Systems Commands are members of the Maury Center. Data collection is accomplished mainly through the use of six AGOR/class research ships operated by the Navy, plus fleet ships and aircraft as projects require.

It is Navy policy that unclassified data resulting from the Ocean Science Program be made available to the marine science community as expeditiously as possible.

Ocean Engineering and Development Program

The Ocean Engineering and Development Program, managed by the Assistant Oceanographer for Ocean Engineering and Development, whose primary duty is Deputy Chief of Naval Materiel for Development, encompasses the efforts in research, development, and technical support of operations necessary to advance the use of the world's oceans and their boundaries. A major goal is to permit the Navy to operate effectively in the ocean at any depth, location, and time, and to provide a technological base for the development and improvement of underwater weapons systems. In particular, this effort is directed toward technologies and systems developments relating to underwater search, rescue, recovery, and construction. In pursuing its objective, the Navy conducts and supports highly diverse oceanographic efforts at 25 major Navy laboratories and institutions. A major portion of the RDT&E effort under this program is accomplished by industry.

The body of data derived from this portion of the program is related to the following technologies: materials and structural design; energy conversion and machinery; sensors, navigation, control, and communications; diver support; environmental prediction and oceanographic survey; acoustic oceanography; and sea floor engineering. These data are not as widely used as the major body of marine information and at present there is no organized system for their archiving. This problem is currently under consideration by the Chief of Naval Materiel and the National Academy of Engineering.

Oceanographic Operations Program

The Oceanographic Operations Program is divided between facilities under the Commander of the Naval Oceanographic Office and the Assistant Oceanographer for Environmental Prediction Services. Under COMNAVOCEANO it is that effort

to provide oceanographic data, services, and operational support, including hydrographic mapping, charting, and geodetic activities; and the initiation and direction of technical support of operations involving underwater search and rescue, recovery, salvage, emplacements, and facilities. The program is worldwide in scope, involving the collection and processing of data, as well as the production and distribution of data products.

The Naval Oceanographic Office mission is to conduct hydrographic and oceanographic surveys, prepare hydrographic and other navigational charts and publications, and conduct the applied oceanographic programs for the Navy throughout the oceans of the world.

The Oceanographic Office utilizes ten hydrographic survey ships and three oceanographic survey ships, and contracts for commercially owned ships in carrying out worldwide deep ocean and coastal bathymetric, magnetic, gravity, and oceanographic surveys in support of navigation, antisubmarine warfare, mine warfare and other Navy missions. Special surveys are also conducted in support of search and recovery operations and for R&D efforts on future warfare systems.

The Oceanographic Office maintains the DOD libraries for bathymetric data and marine magnetic data, and for nautical charts. It maintains an agreement with C&GS for the exchange of magnetic data. Unclassified oceanographic data are pre-processed and turned over to the National Oceanographic Data Center. Classified and highly specialized data are retained in data banks at NAVOCEANO for use in publications and/or research related to specialized naval requirements.

At present, the Oceanographic Office produces approximately 8,500 separate nautical, aeronautical, and oceanographic charts and publications for the Navy, for industry, and for the general public. These charts are distributed throughout the world.

As noted, the operational environmental prediction program of the Navy is under the management of the Commander, Naval Weather Service Command, who is also the Assistant Oceanographer of the Navy for Environmental Prediction Service. The program is defined as that effort to provide short-term forecasting of certain oceanographic environmental conditions--including thermal structure, sea, swell, surf, ice and their applications to fleet operations including sonar conditions, optimum track ship routing, and SAR conditions. (Longer term forecasts are the responsibility of NAVOCEANO, since they are based primarily on historical data.)

The Naval Weather Service maintains a network of some 33 activities that produce highly specialized environmental predictions for the northern hemisphere oceans. The Fleet Numerical Weather Central is at the hub of the Naval Environmental Data Network (NEDN) which links computer facilities used in the collection, processing, and dissemination of oceanographic and meteorological data and predictions. Regional Fleet Weather Centrals/Facilities and Environmental Detachments at virtually all naval operational activities provide specialized and tailored local oceanographic products to satisfy fleet requirements, thereby eliminating the need for local data analysis and conversion to tactical parameters. Presently, about 25 percent of the Naval Weather Service effort involves oceanographic predictions. The effort has increased markedly in the past several years and is continuing to increase.

Lake Survey

The Lake Survey is an agency of the Corps of Engineers. Its mission is to prepare nautical charts, water level forecasts, and certain historical environmental data products for the Great Lakes area. The Great Lakes Research Center (GLRC), part of the Lake Survey, is the DOD scientific and technical information analysis center for the Great Lakes.

Data collected or acquired from other agencies by GLRC include those relating to water levels, waves, meteorological conditions, surface temperature, currents, and water quality. The products produced at the present time are weekly and monthly water level forecasts, and yearly water level catalogs. There are plans to issue a water characteristics atlas. The Lake Survey Hydrographic Branch also collects sounding data and other data related to navigation and prepares smooth sheets from computed data. These smooth sheets are then utilized as a basis for the preparation of nautical charts.

Coastal Engineering Research Center (CERC)

CERC is also an agency of the Corps of Engineers. Its mission is to investigate and report on subjects of interest to coastal engineering projects, including analysis of coastal erosion, beach nourishment, and wave forces. Much of the data utilized by CERC is collected by the Corps of Engineers; however, surf and other environmental observations are also obtained from other sources, including the Weather Bureau, the Coast Guard, state park employees, etc. Great Lakes data are also obtained from the Lake Survey.

The coastal surf and wave data, obtained by both observations and the use of gauges, are used to produce statistical wave analyses for U.S. coastal areas (including the Great Lakes coasts) in connection with beach erosion studies. Plans now exist to produce bottom sediment thickness charts for several sites on the Atlantic coast.

Environmental Science Services Administration (ESSA) (Department of Commerce)

Coast and Geodetic Survey (C&GS)

The Coast and Geodetic Survey prepares nautical and aeronautical charts that promote the safety and efficiency of marine and air navigation, and conducts surveys to develop and maintain the precise geodetic control network essential to mapping and engineering projects. Environmental forecasting activities

include tide and tidal current predictions, tsunami warnings and estuarine flushing predictions, the latter service being on a test basis at present. The Tsunami Warning Center maintains a network of seismic and tide stations around the Pacific basin and coordinates the operation of a warning dissemination network. Seismographic and tidal data are used to detect and measure seismic activity, locate the epicenter, and predict the arrival time of the resulting wave. These predictions are then disseminated as warnings.

The principal marine activity of the C&GS is the production of standard nautical charts, small craft charts and the tide and tidal current tables. The job of providing domestic nautical charts for commercial, recreational and military use is almost uniquely that of the C&GS. "Domestic" in this sense includes the harbor, coastal and offshore waters of coterminous U.S., Alaska, and Hawaii. The bulk of the sounding data for these charts is collected by C&GS vessels, but some depth information is acquired from NAVOCEANO and the Corps of Engineers. Additional chart information on aids to navigation, regulations, restricted areas, etc., is gathered from other government agencies and from local sources.

Additional C&GS products include tidal current charts, coast pilot, bathymetric and geophysical maps and copies of hydrographic survey sheets.

Environmental Data Service (EDS)

The Environmental Data Service, which includes the National Weather Records Center, collects, processes, archives, publishes, and disseminates environmental data collected on a global scale from a variety of sources, including foreign cooperating agencies. The NWRC data bases include marine sea surface and upper air files. Marine climatological atlases and other climatological products are produced from these files. EDS also maintains files for geodetic, geomagnetic, seismological, and other geophysical data, and produces descriptive and historical products based on these files.

National Environmental Satellite Center (NESC)

The mission of NESC is to plan, implement, and operate environmental satellite systems; to collect and analyze satellite-derived data; and to develop new methods of utilizing satellites to provide solar, ionospheric, oceanographic, and other earth-science data. The data acquired include snow cover, sea surface temperature, average brightness, nd cloud imagery. These data are disseminated to forecasting agencies, both national and international, and are used in the production of hemispheric weather charts, sea surface temperature charts, average brightness charts, upper wind prognoses, ice atlases, cloud distribution charts, and weather, sea state, and ice forecasts. Data acquired by the National Meteorological Satellite System are archived at the NWRC. Experimental satellite d are deposited at the National Space Data Center.

Weather Bureau (WB)

The principal operational centers of the Weather Bureau with marine responsibility include the National Meteorological Center (NMC), the National Hurricane Center (NHC), the Marine Forecast Units, and other designated Weather Bureau offices. The overall responsibility of the Weather Bureau is to collect weather data for the United States and its possessions, and to report the weather for these areas; to provide weather, sea state, river, and flood forecasts for the general public and for special interests such as aviation, agriculture, fire, weather, and marine; and to issue warnings against tornadoes, hurricanes, storm surges, floods, and other weather hazards.

The NMC collects surface and upper air synoptic data from the worldwide observational network and processes them into basic weather analyses and prognoses for use by the Weather Bureau field offices. The data supplied by the network are also made available to FNWC. Satellite-derived products are obtained from NESC. The NMC, using a combination of numerical and manual techniques, produces

analyses and prognoses for the Northern Hemisphere, including oceanic areas. Extended-range weather forecasts and sea state forecasts are also produced.

The Marine Weather Forecast Units, located at Weather Bureau offices in Washington, D.C., San Francisco, and Honolulu, use the large-scale products produced and disseminated by NMC as guidance material in the preparation of marine weather forecasts for their respective areas of responsibility in the Atlantic and Pacific Ocean areas. Coastal and Great Lakes weather forecasts for local use are prepared and issued by designated Weather Bureau offices.

The National Hurricane Center, located at Miami, has overall responsibility for supervising the hurricane warning service in the Atlantic, Caribbean, and Gulf of Mexico. It issues warnings and forecasts for hurricane-affected areas. Weather Bureau offices at Boston, Washington, D.C., San Juan, and New Orleans have warning responsibility only. The offices in Honolulu and San Francisco have both forecasting and warning responsibility for hurricanes in the central and eastern North Pacific areas, respectively.

ESSA Oceanographic Research Activities.

The oceanographic research activities of ESSA are directed toward increasing the understanding of the ocean's physical properties and processes by studying their influences on, and interaction with, the physical environment. Their purpose is to allow for fuller exploitation of the marine environment and to support those of ESSA's marine environmental service program that are essential to the safe and efficient use of the ocean as well as of coastal and estuarine waters. In addition, one of its goals is to contribute to national needs for improving oceanographic investigative techniques and instrumentation. Its main areas of research are:

- Structure and motion of the ocean
- Ocean basin characteristics
- Sea-air interaction
- Seismic sea wave (tsunami) research

These activities are conducted from laboratories located in Miami, Florida, and Seattle, Washington, using ESSA's oceanographic ships and other arrangements for the observational phases of the research.

Department of the Interior

Bureau of Commercial Fisheries (BCF) and Bureau of Sport Fisheries and Wildlife (BSF&W)

The Bureau of Commercial Fisheries is responsible for Federal support of fisheries management, fisheries development and exploitation, and fisheries processing and distribution technology. Its specific functions, ranging from scientific studies to economic analyses, include:

- Ecological studies to determine productivity processes
- Resource assessment studies
- Studies to determine methods of minimizing deleterious effects on propagation in estuaries and inshore waters resulting from man-made changes in the environment
- Resource management studies to determine regulatory actions
- Studies to locate new fisheries resources
- Statistical documentation to provide a basis for protection of fishing rights
- Studies to advance the technology of fisheries harvesting
- Studies to improve the quality and economics of processing
- Investigation of distribution and marketing methods

- Dissemination of fisheries information

- Fishery economics analyses

In carrying out these activities, BCF collects and analyzes a wide variety of data. These data are in three broad categories: environmental and biological data, catch data, and processing data. These data are collected by BCF vessels, obtained from other data-producing agencies, or obtained from educational institutions, from the fishing fleets, and from processors and distributors. Products produced from the first category include technical reports, fish abundance forecasts, and an albacore fishery daily advisory. Statistical reports, of value principally to processors, distributors, and fishing managers, are produced from the second category of data. The Bureau of Sport Fisheries and Wildlife (BSF&W) has similar responsibilities in the area of sportfisheries and produces reports, atlases, etc.

Geological Survey (GS)

The U.S. Geological Survey is responsible for the following marine activities:

- Investigation and mapping of the geology and potential mineral resources of the continental shelves

- Investigation of the surface and subsurface water resources of the coastal zone

- Topographic mapping of the coastal zone

- Supervision of oil and gas leasing and production on the outer continental shelves

In carrying out these responsibilities, USGS collects and processes data on the quantity and quality of stream discharges (Water Resources Division); geology, geophysics, and geochemistry of coastal and continental shelf areas

(Geologic Division); topography (Topographic Division); and leasing and production in continental shelf areas (Construction Division). The products produced from these data include a variety of professional papers, reports, abstracts, and circulars relating to specific problems, including water supply, standardized geological maps of offshore areas at three different scales, standard topographic and bathymetric maps, and hydrologic atlases that emphasize flooding data.

Duplicate samples of bottom cores collected by the USGS are forwarded to the Smithsonian Oceanographic Sorting Center for storage and processing. Marine geological data are stored by NODC.

Federal Water Pollution Control Administration (FWPCA)

The FWPCA is responsible for the maintenance of water quality in interstate waters. Coastal waters, including estuaries, harbors, inlets, etc., are defined by statute as interstate waters, as are all the Great Lakes. The FWPCA is, therefore, responsible (in cooperation with the coastal State governments) for the maintenance of water quality in the coastal marine environment. In meeting this responsibility the FWPCA has set water quality standards for the coastal waters. The maintenance of these standards will require monitoring programs, and a portion of the data collected will be entered into the FWPCA STORET system. These data will be used for water quality surveillance, enforcement, and planning, principally by FWPCA but also by the respective States, the USGS, and other interested agencies.

Products produced by the FWPCA at the present time include various technical and research reports and water quali[illegible]ummarizations for selected regions. Cooperative projects with various State agencies also result in the production of water quality and pollution control reports.

Other Agencies, Department of the Interior

In addition to the BCF, USGS, and FWPCA, several other agencies within the Department of the Interior are lesser sources of data, and produce various documents that are used primarily for planning and management purposes. These agencies include the Bureau of Land Management, the Bureau of Mines, the Bureau of Outdoor Recreation, the National Park Service, and the Office of Saline Water. These agencies are principally users, and are of minor significance in data and data product production.

Coast Guard Oceanographic Unit (CGOU) (Department of Transportation)

The mission of the CGOU is to support Coast Guard oceanographic operations and the research of the International Ice Patrol. Functions included in this responsibility include the planning of Coast Guard oceanographic programs and operations and the support of existing programs and operations. The latter function involves the supervision of oceanographic data collection from 34 Ocean Station Vessels, 8 Ice Breakers, 2 Oceanographic Vessels, 1 offshore platform, and 1 large buoy. The types of data collected include physical, chemical, geological, biological, and meteorological data. Data collection is principally by Nansen casts, STDs and XBTs. Real-time processing and quality control is carried out for physical and chemical data, and processed data are delivered in real time to users. Processed physical and chemical data are also submitted to NODC, and other types of oceanographic data are submitted to other users for processing. The data are used by the CGOU for analyses, interpretations, and the preparation of reports.

Oceanographic operations and research are also carried out in support of the International Ice Patrol. These operations have included the monitoring of ice conditions by satellite.

Smithsonian Oceanographic Sorting Center (SOSC)

The functions of SOSC are to collect, preserve, sort, and store biological specimens and core samples; to distribute these specimens and samples with all of the collection and environmental data to selected marine scientists for analysis; and to permanently record the results of the analyses and related scientific investigations. These functions are performed either in response to the needs of broad oceanographic explorations (e.g., International Indian Ocean Expedition, U.S. Antarctic Research Program) or in response to specific operational inquiries which may be received from the Navy, AEC, BCF, or any other legitimate government or scientific source.

SOSC has developed a data system for storing and retrieving taxonomic and descriptive information for each biological specimen processed. The current objective is to build up the data base and develop a capability for flexible selective retrieval--for example, by expedition, species, location, time, and method of collection. Data products consist of scientific papers by staff scientists, and catalogs of the collection.

The primary marine science mission of the Smithsonian Institution is to carry out basic investigations of marine populations, of the distributions of organisms and sediments in the ocean, and of the taxonomy of marine organisms. It provides assistance and support to international as well as to national programs. Its 50 marine scientists carry out and participate in the planning and field operations of biological and geological expeditions, and report on the results of their studies of collections obtained on these expeditions.

In relation to its various internal missions, the Smithsonian's fundamental goals are to operate as a research organization performing basic research in natural history, which is defined to include systematics, ecology, geology and anthropology; to support education in natural history from preschool to post-doctoral activities; and to care for and to increase the national collections

in zoology, botany, anthropology, and geology. The research program of the Smithsonian is focused on the physical specimens of its collections and the specimens to which it has access through a museum exchange program.

The Smithsonian participates in Bureau of Commercial Fisheries cruises, processes BCF data at the SOSC, and provides BCF with extensive biological information. BCF maintains an overlapping collection of fish specimens with the Smithsonian, although the latter's is substantially larger. Excellent liaison is maintained between the two agencies.

The Smithsonian's extensive historical specimen collection is of great value in supporting studies of environmental and ecological changes that are important to pollution studies.

The Smithsonian participates in and supports international scientific surveys, and the SOSC serves customers from 26 countries. It participates in extensive international specimen exchange and loan programs and sends members of its staff to perform field investigations throughout the world as well as research at foreign museums. The research of many scientists from other nations is also supported at the Smithsonian.

The Smithsonian serves as a major educational resource in oceanography and the other natural sciences. It is in communication with virtually all the educational establishments of the nation and many overseas establishments that are concerned with oceanography. It participates in a number of scientific endeavors together with various universities; an example is the consortium of academic institutions that is now developing scientific research programs for the Chesapeake Bay Center for Field Biology.

Basically, the Smithsonian's data program mission is to acquire and maintain a complete and representative specimen collection in marine zoology, botany, and, to a lesser degree, marine sedimentology. The individual specimen types constituting these collections need to be gathered continuously to provide the

necessary historical record. The specimens need to be preserved, identified, described, indexed, catalogued, and stored. In like fashion, scientific documents, studies, and papers that have relevance to marine biology and zoology must be acquired and catalogued.

In handling specimen inputs, the Smithsonian is required to physically sort the material and retain together with it whatever descriptive information is received. Several levels of information beyond the individual physical specimen need to be captured or developed. Since the specimen may represent an object of particular ecological, nutritional, toxicological, or pharmacological interest, various identification parameters must be cross-indexed with specimen contents. As new information about the specimen is acquired, it must be properly retained in the aggregation of information that has evolved about the specimens. The information requirement for physical specimens poses a unique data management problem.

Earth Resources Aircraft Program (ERAP)

The Earth Resources Aircraft Program, located at the NASA Manned Spacecraft Center in Houston, carries out studies to develop remote sensing techniques that can be utilized in oceanography, geography, geology, hydrology, agriculture, forestry, cartography, and commercial fishing. The program has several aircraft that are equipped with various sensors. These aircraft are used to collect data for research and development programs sponsored by various educational institutions and by NAVOCEANO, ESSA, USGS, BCF, and the Jet Propulsion Laboratory. The sensing equipment includes metric, multiband, and boresight cameras; infrared scanners, spectrometers, and radiometers; microwave radiometers; and scatterometers and side-looking airborne radars. Various combinations of these sensors have been used on data collection flights over a number of specific oceanographic study areas. The data collected on each mission are processed into the ERAP data bank. Reports are prepared by the principal investigators and stored in the ERAP data bank. Mission documents, test site maps, and data accession lists are produced by ERAP.

National Oceanographic Data Center (NODC)

The National Oceanographic Data Center is the principal U.S. oceanographic data repository. It functions as a service activity for the oceanographic community by acquiring a wide spectrum of data from diverse domestic and foreign sources and compiling, processing, and storing these data for ready retrieval. Summaries, tabulations, analyses, evaluations, and indexes of the data holdings are made available to the user communities. NODC does not originate primary data; it is included in the list of producers because it is a major source of accumulated oceanographic data and does produce data products upon request.

NON-FEDERAL AGENCIES

Regional, State, and Local Organizations

Regional, State, and local organizations of various sorts are significant producers of some categories of data, particularly for coastal waters and shoreline activities. Regional agencies are those whose activities are concerned with a natural division of a coastal or oceanic area regardless of State boundaries. Examples of regional agenices are the Southeastern Fisheries Association, the Gulf States Marine Commission, and the Gulf Universities Research Corporation. As a general rule these agencies use marine data for planning purposes; in some cases, however, they produce data products in the form of reports.

Every coastal State has a number of agenices who are producers of data and products, or both. For example, in the State of California there are several councils and commissions concerned with coastal and oceanic resources, a State Planning Commission, a coordination council for higher education, and the San Francisco Bay Conservation and Development Commission. These agencies use marine data and data products for planning and management purposes. For example, California State agencies that produce data and/or products are:

- Department of Conservation
- Department of Harbors and Watercraft
- Department of Public Works
- State Lands Commission
- Water Resources Control Board
- Regional Water Quality Control Boards (6 coastal boards)
- Department of Water Resources
- Department of Fish and Game
- Department of Parks and Recreation

Each of these agencies has a specific and well defined responsibility for the coast and coastal waters within State jurisdiction. In meeting these responsibilities a variety of data are routinely collected and diverse data products are produced. Only a minor part of these data are currently included in Federal agency data banks. The situation differs only in detail in other coastal states.

Local agenices include Sanitation Districts, County and City Parks and Recreation Commissions, local Harbor Districts, and other local organizations. These agencies also produce data and products (mostly reports) that may be forwarded to State agencies. Few, if any, of these data or data products find their way into Federal agency data banks.

Institutions and Universities

Research institutions and universities are major collectors of data collected either during expeditions or in connection with specific study projects. In the latter case, data may be collected on a routine basis within a limited area, and for specific parameters of interest to the study. A majority of these expeditions and projects are supported directly by Federal agencies and some of these data are ultimately submitted to NODC. Some of these data are unique, and are not normally available from other sources.

Individual research scientists utilize the data they collect in analyses that are published as scientific and technical papers and reports. In many instances an investigator requires data not collected in connection with his project or by his institution. These data are either obtained directly from the investigator who collected them, or from data bases such as those at NODC, NAVOCEANO, and SOSC. Although the production of data and data products by research scientists is sporadic, and although what is produced is usually specialized, academic and institutional research scientists are a key segment of the marine data user and producer community, since the products they produce often significantly advance the overall understanding of oceanographic problems and thereby lead to better methods of management and exploitation.

Industrial Organizations

Merchant Shipping

Mariners play a major role in collecting marine weather data (and, consequently, weather observations over oceanic areas are concentrated along shipping lanes). Worldwide surface weather observations from selected cooperative vessels are normally radioed to designated Weather Bureau offices every six hours. Visual observations of the sea state, cloud cover, visibility, present weather, and past weather are included. Quantitative measurements of the barometric pressure, air temperature, sea surface temperature (usually the temperature of sea water in the engine room's intake), and ship's position are also made. The wind speed and direction are determined either by the use of an anemometer or by visual observation of the sea state and the direction of spray from white caps and/or the direction of the wind waves. Wet bulb temperature, ice and observations of special phenomena are sometimes included. Upper air observations are made on some merchant vessels by Weather Bureau personnel. The surface and upper air observations are used by the Weather Bureau to prepare various marine weather forecasts which are disseminated to merchant ships by commercial, Navy, and Coast Guard radio stations. The meteorological services

of major maritime nations often supply, maintain, and periodically calibrate the ship's barometer and some of the other measuring instruments.

When operating in the U.S. area of responsibility, the ship's radio operator transmits weather reports to the nearest commercial, Navy, or Coast Guard radio station, which then relays them to the ESSA Weather Bureau. The Bureau pays transmission charges and, in some cases, overtime wages to the radio operators of selected U.S. ships.

The Navy provides instrumentation to selected commercial ships for subsurface data collection. In addition, merchant ships have made millions of observations of sea surface temperature, currents, and waves, and have transmitted these data to NAVOCEANO in exchange for navigational charts. The subsurface data generally are a prediction program input, whereas the temperature, current, and wave data provide inputs to atlas products.

Offshore Oil and Gas Production

Offshore drilling and production operations require highly localized and data detailed data. In selecting an area for an oil survey, a company will utilize all of the relevant data and data products available from Federal, State, university, and institutional sources. These data and products are public information. The basic decision to invest funds for a survey is based on this information.

The detailed geological and seismic data resulting from the company surveys are proprietary. This information is used in-house by the company. In some cases raw data (e.g., well logs) collected by the company may be sold to other companies, and in a few cases specific proprietary data is provided to interested government agencies (DOD, USCG) with the understanding that these data will be handled as confidential. These data are provided in addition to non-proprietary information that the companies are required to routinely file with the USGS.

Normally, an offshore operation will require the company to also obtain highly localized data on maximum wave heights and periods, storm frequency, average and maximum tides, and current characteristics. These data are not considered proprietary. The offshore oil and gas production industry is, therefore, a significant producer of data; however, most of these data are not available for public use.

Ocean Engineering

Ocean engineering companies are those involved in salvage operations; ship and submersible design; harbor, marina, breakwater, and outfall design and construction; underwater engineering; instrument/communications design and development; and consulting, studies, and equipment development. The ultimate output of the activities of an ocean engineering company is either a design, a structure, a piece of hardware, or a hardware system. The data required are obtained from diverse sources, but are seldom collected by the companies themselves. The data products produced include design studies, site investigation reports, operational reports, and manuals. Many of these data products are closely guarded proprietary items that are used in developing further business by the companies or are cycled back into further design or operational efforts. These industrial organizations are producers of both data and products, neither of which are intended for public use.

Marine Mining

The operations of offshore mining concerns are similar to those of oil and gas concerns. They are users of available data and data products, particularly those that pertain to the location and exploitation of mineral deposits and those that directly affect the actual mining operations. The companies require detailed geological and environmental data for a specific site. These data are obtained either by the company or by contract to marine service companies, and, along with specialized engineering data, are regarded as proprietary.

Marine Cable Laying

Cable laying companies are primarily users of data and data products; however, it is often necessary to obtain more complete and more detailed bathymetric data than are available in existing data banks and products. These detailed data are usually obtained by contractors and are generally available for public use.

Marine Services

The majority of the work performed by marine service companies is oriented to the petroleum industry, and includes activities such as surveying, diving, seismic studies, and oceanographic studies. Some of these efforts provide data and data products that may be released by the contracting company; however, a majority of the data are proprietary. The same types of work are performed for non-petroleum-oriented activities, in which case the data are usually not considered to be proprietary.

DELINEATION OF USER COMMUNITIES

Users of marine data and products may be divided into 12 discrete communities, ranging from private individuals who require information concerning swimming conditions at the local beach, to specialized government agencies with the responsibilities of providing environmental forecasts, information products for navigation purposes, and other complex data products. Each of these communities has a different orientation to marine data and products. Though there is a significant overlap in the needs of these communities, and significant interaction between some, each community has a unique set of requirements.

The communities are defined by the activity that characterizes them. The first two are users of data and intermediate data products, and produce data end-products for the other communities; the remaining 10 are users of end-products. The communities are:

1. Environmental forecasting
2. Environmental description
3. Naval operations
4. Merchant shipping
5. Ocean engineering
6. Industrial operations
7. Fishing
8. Recreation
9. Education
10. Federal, State, and regional planning and management
11. Research
12. Public at large

The diversity of these communities, their differing requirements for marine data and data products, and the relative independence of the development of needs within any one community from that in the others, have been in large part responsible for the growth of a need for a more effective marine data management program. The following sections contain descriptions of each of these communities and their requirements.

ENVIRONMENTAL FORECASTING

The environmental forecasting community is composed of those agencies charged with the responsibilities of providing warnings and forecasts of marine weather, and sea state conditions in addition to certain oceanographic forecasts, tide and tidal current predictions, fishery advisories, and other related data products. The dominant activity in this community is the acquisition and processing of marine environmental data required to produce marine weather and sea state forecasts. This activity is carried out by the Weather Bureau, the Naval Weather Service Command, and private environmental forecasting companies. Oceanographic forecasts (e.g., of thermal structure and sea surface temperature) are prepared by NAVOCEANO and the Naval Weather Service Command.

The Naval Weather Service Command also produces forecasts of sea ice distributions, and occasionally NAVOCEANO provides tide and tidal current predictions for remote operational areas. The Coast Guard prepares iceberg advisories. The Coast and Geodetic Survey prepares tide and tidal current predictions for the U.S. and its possessions, operates the National Tsunami Warning Center, and is involved in a pilot project for estuarine flushing predictions.

The La Jolla laboratory of the Bureau of Commercial Fisheries prepares daily advisories for the West Coast albacore fishing fleet, and other BCF offices prepare annual fishery abundance forecasts.

The end products of major importance produced by these agencies are forecasts and warnings in alphanumeric and graphic form. In the preparation of these products both raw data and certain data products are used. Current synoptic data (e.g., merchant ship weather reports, coastal and island meteorological observations, ocean station observations, satellite-obtained cloud imagery) are of particular importance. Intermediate data products are used principally within the respective agencies to prepare end products for use by other user communities. Historical environmental description products (e.g., climatological atlases, mean monthly ice distribution charts, storm track plots) are also used in the activities of the agencies in this community.

ENVIRONMENTAL DESCRIPTION

The environmental description community encompasses the various agencies concerned with the production of data products that describe the marine and coastal environment. There are several categories of products, including historical marine environmental products (e.g., climatological atlases, ocean station atlases, wave and swell charts), physical description products (e.g., bathymetric maps), navigational products, engineering support products, fishery statistics reports, and water quality and pollution reports. Agencies involved in these activities include the ESSA-Environmental Data Service (National Weather

Records Center), NAVOCEANO, Coastal Engineering Research Center (Army Corps of Engineers), ESSA Coast and Geodetic Survey, U.S. Lake Survey, U.S. Geological Survey, Bureau of Commercial Fisheries, NODC, various State and regional agencies, various educational institutions, and some industrial concerns.

This diverse community requires a variety of data that are obtained from a large number of sources. Climatological atlases are produced from observations made by merchant ships, meteorological satellites, aircraft, fishing vessels, buoys, etc., and synoptic charts. Physical properties atlases are produced from ocean station data. Surface current charts are prepared from set and drift observation data and current-meter data. Nautical chart preparation requires data from a number of sources, as do marine geological atlases. Fisheries atlases require still different types of data.

As in the case of environmental forecasting, this community both uses and produces data and data products. A few of the data products are of interest only within this community; however, most of them are produced for the use of all user communities.

NAVAL OPERATIONS

As the single greatest user of oceanographic data and data products, Naval operational units rely on data inputs from various sources not only within the Navy and DOD agencies, but also from other user communities. Many of the data and data products generated within the Navy are also used directly by other user communities. An environmental forecasting network (which includes marine meteorological and oceanographic forecasts) operated by the Naval Weather Service, through its Fleet Weather Centrals, is organizationally included in Naval operations and, as such, is closely tied to operational requirements. Naval operations are dependent upon various naval laboratories and research units for product developments. The operating forces, both sea and air, include surface fleet ships, ASW forces, the submarine force, amphibious forces, and mine warfare forces.

The needs of the operating forces also include environmental description products, which, for the most part, are data products originating mainly within the Naval Weather Service, NAVOCEANO, and the Navy laboratories (NOL, USNUSL, NURDC, etc.). These include climatological atlases; navigational, nautical, and bathymetric charts; sonar atlases; etc. As a user, the Navy is, through its planning and operation functions, closely tied to the environmental forecasting, environmental description, ocean engineering, and research communities. In addition, a somewhat looser overlap exists with the fishing, industrial operations, and merchant shipping communities.

MERCHANT SHIPPING

The merchant shipping community is composed of transoceanic, coastal, and Great Lakes shipping operations and their support organizations. In contrast to the three communities previously described, this activity-oriented group is primarily an end user of data and data products. Merchant vessels under way provide weather, sea state, ice, and other observations. While this activity is secondary, it is of importance to their operations. Shipping interests may also provide ocean engineering information (e.g., vessel design and construction), but they are primarily users of these data and products.

This community uses extended forecasts of marine weather, sea state, and ice distribution, in conjunction with current atlases, climatological atlases, and various navigational aids and nautical charts, to route ships. The objectives are to avoid conditions that may prove hazardous or cause delays, to minimize the time enroute, and to maximize the use of fleet vessels. Effective route planning can significantly reduce the costs of shipping per ton of cargo. Short-term forecasts and warnings are used while under way to update routing plans and to revise shipboard operations in response to changing conditions.

OCEAN ENGINEERING

The ocean engineering user community is composed of all of the Federal and public agenices and private concerns involved in engineering activities related to the marine environment. These activities fall into six general categories:

- General purpose engineering
- Vehicle and structure engineering
- Instrumentation/communication engineering
- Deep ocean technology
- Military engineering
- Safety engineering

The U.S. ocean engineering community includes approximately 50 companies involved in salvage operations, 40 in ship and submersible design, 30 in harbor and marina design, 160 in underwater engineering, and others in coastal engineering, consulting, study, and equipment development. The field also includes a number of military facilities and laboratories. Most of these activities are carried out by a diversity of Naval Laboratories and centers.

In design and development, this community uses various engineering data products, a wide variety of marine historical environmental products, marine physical description products, and biological data products. In the operational phase, marine weather, sea state, surf, tide, and other oceanographic forecasts are required, as well as navigation data products.

INDUSTRIAL OPERATIONS

This community includes the various industries involved in offshore oil and gas production, marine mining, marine cable laying, non-fisheries harvesting (e.g., kelp), and offshore surveying and services. At least 100 oil companies, 10 major geophysical contractors, and 100 major oil contractors are involved in offshore drilling, engineering, and pipeline construction. Offshore mining

is presently a relatively small commercial undertaking, occupying some 30 mining and service companies. Approximately 10 marine telephone cable companies are still laying cable wherever it is competitive with newer techniques.

Industrial use of marine data and products is characterized by (1) the use of all available data (public and private) when deciding to undertake a survey or project, (2) use of Federal weather and sea state, navigation, and bathymetry products in support of the survey or project, and (3) the proprietary nature of the detailed geophysical and geological survey data that are collected by the companies themselves.

FISHING

This community includes five areas of activity:

- Commercial fishing
- Sport fishing
- Processing and distribution of fisheries products
- Management of the fisheries resource
- Fisheries research

The commercial segment is composed mainly of small, private entrepreneurs spread over a wide geographic area and oriented toward a variety of different commodities. In 1967, some 136,000 U.S. commercial fishermen operating more than 82,000 fishing craft accounted for a catch of over four billion pounds of fish and shellfish worth $438 million. The number of U.S. commercial fishermen has been steadily declining since 1950, while the number of sport fishermen has been increasing rapidly. According to the latest published estimates, the U.S. sport fishing sector includes at least 8 million salt water anglers who annually spend more than $800 million. As of 1967, there were $4,187 fishery shore establishments employing 89,000 persons. Processors, distributors, and resource managers are major producers and users of fishery statistics.

Fisheries research is conducted mainly by the U.S. Bureau of Commercial Fisheries, the Bureau of Sport Fishing and Wildlife, State fishery departments, private fisheries research laboratories, and universities. Fisheries research was conducted at 46 laboratories and field stations by the BCF in 1966. The BSF&W currently maintains four marine research laboratories. Eighteen coastal and Great Lakes States maintain marine fishery laboratories, and numerous universities and private institutions are performing fisheries research under contracts from Federal and State agencies.

Resource managers are primarily interested in relating catch to effort (catch, type of gear, number of ships and type, crew size, time spent, etc.) in order to achieve the maximum sustainable yield of a given fishery. The Atlantic States, Pacific, and Gulf States Marine Fisheries Commissions were established in the 1940's to promote better use of marine, shell, and anadromous fishery resources, as well as to ensure that these resources are properly managed and preserved. The 77 members of these three commissions represent 23 States. Though the regulatory power over U.S. fisheries is vested in the individual States, the BCF plays an important role in offering recommendations, based on the results of resource-management research, to both national and international fishery commissions. The U.S. is also a party to eight major international fishery commissions concerned with the management and conservation of fishery stocks.

RECREATION

The greatest numerical demand for environmental forecasting and warning services comes from the public recreation user community. Marine recreational users include those who utilize the beach during the day for various purposes, including swimming, surfing, and sunbathing, boating and water skiing, coastal camping, shore and nearshore fishing, waterfowl hunting, skin and scuba diving, and the study of marine life. Generalized forecasts of marine and coastal weather, sea state, and surf conditions are satisfactory for most of these users; however, some boating activities, such as predicted log racing, require

more detailed forecasts. Nautical products, particularly those provided for small craft operations, are used extensively by this community, as are nautical charts, tide tables, tidal current tables and charts, and various specialized brochures and books relating to diving conditions, fishing conditions, hunting, and camping. The growth in number of citizens participating in swimming, surfing, diving, boating, fishing, sunbathing, and sightseeing is anticipated to increase from 75 million annually in 1964-5 to 95 million in 1970 and 120 million in 1975.

EDUCATION

The education community includes teaching at all levels in public and private institutions. Marine publications of all types are used in the schools. Most of these publications are textbooks, at various levels, concerned with some aspect of the marine environment. Direct use for educational purposes is also made of data products such as bathymetric maps, environmental atlases, geological products, and thermal structure charts. These products are also used to educate user groups in their application.

In coastal communities there is an increasing trend toward more field trips by groups of students to either study shoreline biological and physical characteristics or to observe surface conditions and make dredge and seine hauls from boats. Various data products are used in planning these field trips, so that appropriate observation and collection conditions, and the safety of the students, are ensured.

The developing national interest in the oceans is reflected in the growth of marine-oriented curricula in institutions of higher learning. Advanced undergraduate and graduate course work involves extensive use of marine data and data products. In response to the growing interest of the ducational community in the oceans, institutional materials are prepared and distributed by all Federal agencies [illegible] institutions. NODC, the National Science Teachers' Association, the Navy, ICMREF, and the Sea Grant Program are major participants

in this program. The growth of the demand for these materials indicates a rapid expansion of this community.

FEDERAL, STATE, AND REGIONAL PLANNING AND MANAGEMENT

Planners and managers become involved in coastal and offshore uses of marine resources through public ownership of lands, regulatory and enforcement responsibilities, or planning for maximum public use and benefit.

Four kinds of public agencies are deeply concerned with the use of marine data products:

- State and regional planning agencies--an estimated 150 boards of natural resources, State land commissions, and governors' councils on oceanography.
- Recreation departments--approximately 75 agencies, such as the National Park Service and State departments of parks and recreation.
- Water Quality and Waste Disposal Agencies--some 75 agencies, including the Federal Water Pollution Control Administration (FWPCA) and State and regional water resources control boards.
- Conservation agencies--approximately 35 agencies, consisting principally of State boards of conservation.

The number of agencies within a State concerned with the marine environment varies; California has 56, Maine 39, Michigan 22. Some States also provide added marine advisory councils or commissions, and there are 89 active interstate organizations across the country. Many of these organizations carry on substantial management programs in addition to their planning and advisory functions.

Organizations whose missions are essentially planning, advising, or policy-making depend on external sources for data. Examples are the California Interagency Commission on Ocean Resources and the working groups formed by the Governor's Conference on Massachusetts' Stake in the Ocean. Such commissions and groups conduct planning studies, hear expert witnesses, canvass relevant literature, and utilize the experience of their members. Frequently they will sponsor special studies by scientific or engineering groups. Their findings are then published in report or study form, making these groups a source of data in their own right.

RESEARCH

Basic and applied marine research is conducted at more than 90 Federal, 40 State, 90 academic, and 25 private laboratories. Basic research investigations frequently have in common the fact that they are designed by a scientist to produce the data required for his own experimental goals rather than for the direct use of the marine data community at large. (This does not, obviously, prevent the later use by the community at large of the results of basic research.) Applied research investigations are directed more toward providing specific answers to practical problems--for example, the improvement of mechanical fishing operations. Most research activities include the collection of extensive data of high quality. Data may also be acquired from oceanographic data bases (e.g., NODC, NWRC, NAVOCEANO), and various data products are used. Most research data products take the form of technical and scientific reports.

PUBLIC AT LARGE

In addition to those segments of the public who can at one time or another be considered most appropriately as members of the recreation, education, or sport fishing communities, there is another part of the public that makes frequent use of marine data products to enhance their appreciation of the shoreline simply as an esthetic resource. In the esthetic appreciation of a beach, a rocky shoreline, or a harbor or marina, various data products may be, and are,

used by the general public. The general public also includes the coastal property owner, who must be concerned with the protection of his property and its inhabitants from the effects of storm surges, storms, tsunamis, and other marine environmental hazards. The number of waterfront dwellers is increasing rapidly in most coastal States, and this segment of the public has a special and unique interest in marine information.

Most marine data product users, and other segments of the public associated with marine operations of all sorts, may require legal counsel. The legal community is, therefore, also a segment of this user community.

MARINE DATA FLOW

COMPONENTS OF THE MARINE DAT ETWORK

The phases of marine data flow include collection, transmission, data processing, data dissemination, analysis, data product preparation, product dissemination, and product use. The standaridized methods of collecting raw data differ for various categories of parameters. There are four standard procedures: (1) direct measurement with sensors, (2) visual observation, (3) sampling and subsequent laboratory analysis, and (4) derivation from measurements of other parameters. Direct readout from standard, calibrated sensors is used to measure some physical parameters (e.g., oceanographic and atmospheric pressures and temperatures, currents, tides, wind speed and direction, depths, acoustic and optical characteristics), and can be used to provide measurements of some chemical parameters (salinity, dissolved oxygen, pH, and radioactivity). Visual observations are commonly used to provide raw data concerning sea state, wind speed and direction, cloud types and coverage, ice distribution, turbidity, and debris distribution. Sampling and subsequent analysis is required for obtaining raw data for parameters such as nutrient concentrations, sediment characteristics, occurrence and abundance of biotic types, microbial pollutants, and so forth. Parameters derived from other direct measurements include density and relative

humidity. There is, therefore, a diversity of standard methods for collecting raw data.

The platforms from which data and samples are collected include ships (merchant, Navy, Coast Guard, Coast and Geodetic Survey, fishing, research vessel, etc.), fixed platforms and piers, shore stations, buoys, gauge installations, aircraft, satellites, and submersibles. Transmission characteristics are determined in part by the type of platform. Manned platforms permit preliminary on-board evaluation and processing prior to transmission, while unmanned automated stations transmit direct measurements on schedule and/or on demand.

Transmission characteristics and subsequent data flows are, however, determined primarily by the ultimate use requirements, i.e., the reasons for which the data are collected. There are five major data flow categories, based on end-use requirements:

1. Research data flow
2. Forecasting products data flow
3. Descriptive products data flow
4. Archiving data flow
5. Design and development data flow

These subnetworks are not independent, except in a few special cases; however, the sets of requirements differ and, therefore, the data flow differs.

Data collected specifically for research purposes usually have relatively stringent collection and instrumentation requirements, depending in part on the collection platform. Although there may be requirements for rapid processing, there are seldom requirements for rapid transmission; in fact, these data are often collected directly by a member of a research project team and hand-carried to a laboratory, where they are maintained in office files. At the appropriate time in the project, the accumulated data are analyzed and a research

report and/or professional paper is prepared. The data may be submitted to an archiving service immediately following collection and preliminary processing, or at some later time; however, some categories of data are commonly maintained only in the files of the originating laboratory. Archival services also provide a source of data for research projects.

The flow of environmental forecasting data and data products is determined by quite different end-use requirements. The accuracy (and, hence, the value) of a forecast degrades rapidly as the delay between the time the observations were made and the time the forecast is prepared and transmitted lengthens. It is desirable, therefore, to acquire and process observational data and produce and disseminate the forecast product as soon as possible following the time of the observations. The characteristics of the data flow networks for these products are determined by this need for timeliness.

Environmental description products include several submodes of data flow; however, the general requirements are for the accumulation of complete sets of data, for a given time period, and/or for a given area, and the preparation of accurate descriptive products containing predefined levels of detail. Timeliness is not (within reasonable limits) a critical factor. Periodic expansion and updating of these products is required, and analysis, storage, retrieval, and archiving systems are essential in these activities.

Research, environmental description, and design and development activities require the accumulation, storage, and retrieval of data. To meet these requirements, data services exist in all of the major agencies involved in producing descriptive products, and several data services (SOSC, NODC, NWRC, NAVOCEANO) directly support research and development activities. The flow of data through these storage, retrieval, and archiving services is, in reality, a part of these subnetworks; however, since the end-uses are distinct, these services are considered a distinct data flow mode.

RESEARCH DATA FLOW

All types of marine data are used directly or indirectly in basic and applied research. The types of data that are collected can be categorized by the general discipline to which they apply--i.e., physical, chemical, geological/ geophysical, biological and fisheries, meteorological, pollution, engineering, and miscellaneous. Major data types are indicated in Table II-1. A large number of individual parameters can be measured within each data type. For this reason, the parameters are combined in the table into parameter groups (e.g., tide parameters, geophysical measurements, fishing statistics, and clouds). The listed parameter groups include most of the measurements commonly made in the marine areas. Auxiliary data indicating time, location, etc., are also collected. A series of general research study areas in which the various data parameters are used are included in the table.

The specific flow of research data is a function of the nature of the data required, the collection requirements, and the goals of the particular study. The generalized flow is indicated in Figure II-1. Raw research data come from two primary sources: expeditions and shore-based project activities. Expedition data include the various types of parameters measured and data from samples collected from research vessels and platforms. Data collected during shore-based operations includes measurements of nearshore waters, shore phenomena, laboratory research at various institutions, and projects requiring extensive collection of synoptic data from widespread areas.

During research expeditions, standard weather and oceanographic (BT, STD, etc.) observations are made and transmitted to the several analysis and forecasting centers, where they are used for forecasting purposes. Weather data are normally of only incidental research interest. All other data collected are included as cruise data (which may include the standard weather and oceanographic observations, ws well as related nonroutine observations). Cruise data are included in the data records, which are most commonly maintained onboard and

TABLE II-1
CORRESPONDENCE BETWEEN PARAMETER GROUPS AND MARINE STUDY AREAS

	DATA TYPE	PHYSICAL								CHEMICAL						GEOLOGICAL AND GEOPHYSICAL						BIOLOGICAL AND FISHERY: POPULATION								BIOLOGICAL AND FISHERY: EXPERIMENTAL				METEOR.				POLLUTION				ENGINEERING						OTHER					
	STUDIES USING PARAMETER GROUPS (EXAMPLES) ↓ / PARAMETER GROUPS* →	PRESSURE, TEMPERATURE DENSITY	CURRENTS	TIDES	WAVES	SWELL, SURF	DRIFT MEASUREMENTS	FRESH WATER INFLOW/EXCHANGE	MIXING PARAMETERS	SALINITY	NUTRIENTS	BUFFER SYSTEM	DISSOLVED GASES	RADIOACTIVITY	ELEMENTS	ROCK OR SEDIMENT SAMPLES	ROCK OR SEDIMENT DESCRIPTIONS	SEDIMENTARY PROCESSES	DEPTH	BOTTOM PHOTOGRAPHS	GEOPHYSICAL MEASUREMENTS	SPECIMEN HOLDINGS	TAXONOMIC POSITION	OCCURRENCE & ABUNDANCE	PRIMARY PRODUCTIVITY	COLLECTION DATA	MIGRATION & MOVEMENTS	AGE, GROWTH, AND MORTALITY	FISHERY STATISTICS	COMPARATIVE PHYSIOLOGY	BEHAVIOR	LATION GENETICS	ENDOCRINOLOGY	AIR CHARACTERISTICS	WINDS	CLOUDS	HEAT BUDGET	CHEMICAL POLLUTANTS	HEAT & RADIOACTIVITY	MICROBIAL POLLUTANTS	OTHER SOLID WASTES	WAVE CHARACTERISTICS	WIND FORCES	CURRENT CONDITIONS	ENGINEERING PROPERTIES OF BOTTOM	SEDIMENT TRANSPORT & COASTAL EROSION	BEHAVIOR OF MATERIALS	ACOUSTICS	ELECTROMAGNETICS	OPTICS	SEA ICE	BIOMEDICINE	IMAGERY
1	OCEAN CIRCULATION	X	X				X	X	X	X	X		X	X		X	X	X	X	X				X										X	X	X	X	X	X										X		X		X
2	VERTICAL STRUCTURES	X	X					X	X	X	X		X	X					X					X	X									X	X	X	X	X	X														
3	AIR-SEA INTERACTIONS	X			X	X		X	X	X			X			X																		X	X	X	X																X
4	TURBULENCE & DIFFUSION	X	X	X	X	X	X	X	X	X			X			X	X																	X	X			X	X														
5	OCEAN TIDES	X	X	X													X		X	X																		X	X	X													
6	WAVES (INCL FORECASTING)				X	X																													X													X					
7	SOUND & LIGHT TRANSMISSION	X			X	X		X		X							X							X			X								X	X	X											X		X			
8	MAJOR CHEMICAL PROPERTIES	X	X				X	X	X	X	X	X	X				X		X					X	X									X				X	X														
9	TRACE ELEMENTS, ISOTOPES, ETC	X	X					X		X			X		X	X	X										X			X				X				X	X														
10	MARINE POLLUTION	X	X	X	X	X	X	X	X	X	X					X	X	X	X			X		X	X			X		X		X		X	X			X	X	X	X												
11	GEOCHEMISTRY OF SEDIMENTS	X	X					X		X		X	X	X	X	X	X	X	X	X		X		X	X	X								X	X																		
12	STRUCTURAL STUDIES	X														X	X		X		X																																
13	MARINE SEDIMENT CHARACTERISTICS	X	X	X	X	X	X	X		X		X				X	X	X	X	X	X	X	X	X	X	X	X				X			X	X			X	X		X				X	X					X		
14	SEA FLOOR GEOMORPHOLOGY	X	X	X	X	X												X	X	X															X																X		
15	DYNAMIC PROCESSES	X	X	X	X	X	X	X		X						X	X	X	X	X	X														X										X	X				X			
16	DISTRIB OF FAUNAL ASSEMBLAGES	X	X	X	X		X	X		X	X	X	X				X		X	X		X	X	X	X	X	X		X	X		X						X		X													
17	SYSTEMATICS																			X		X	X	X		X	X				X	X																					
18	PRODUCTIVITY & THE FOOD CHAIN	X	X								X	X	X				X			X		X		X	X	X	X	X	X	X						X	X													X	X		
19	FISHERIES ENVIRONMENTAL FACTORS	X	X	X			X	X		X	X		X				X		X	X		X		X	X	X	X	X	X	X	X	X	X					X	X	X	X												X
20	FISHERIES POPULATION DYNAMICS																					X		X		X	X	X	X			X																					
21	FISHERIES MANAGEMENT																							X		X	X	X	X		X																						X
22	AQUACULTURE	X	X	X	X					X	X						X							X	X		X	X	X	X	X	X	X					X		X					X	X	X						
23	ENVIRONMENTAL PHYSIOLOGY	X		X	X			X		X	X	X	X						X			X	X	X						X		X	X																				
24	OCEANOGRAPHIC PREDICTION	X	X	X	X	X	X			X																								X	X	X	X					X	X	X				X			X		X
25	NEARSHORE AND OCEANIC RESOURCES	X	X	X	X	X		X		X	X		X			X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X
26	COASTAL, ESTUARINE, LACUSTRINE	X	X	X	X	X		X	X	X	X		X			X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X		X
27	PORT DEVELOPMENT		X	X	X	X										X	X	X	X		X													X	X	X		X	X	X	X	X	X	X	X	X	X				X		
28	WASTE DISPOSAL AND HEALTH	X	X	X	X	X	X	X	X	X	X		X			X	X	X	X	X		X	X	X	X	X	X	X		X					X			X	X	X	X	X	X	X	X	X				X			X
29	COASTAL ENGINEERING		X	X	X	X	X	X	X							X	X	X	X		X														X			X	X	X	X	X	X	X	X	X	X				X		
30	ESTUARINE PROCESSES	X	X	X	X		X	X	X	X	X		X			X	X	X	X	X	X	X	X	X	X	X	X			X	X			X	X		X	X	X	X	X	X	X	X	X	X	X			X	X		X
31	OFFSHORE & DEEP OCEAN DRILLING		X	X	X	X										X	X	X	X	X	X														X							X	X	X	X	X	X				X		
32	DEEP OCEAN TECHNOLOGY	X	X	X	X	X				X						X	X	X	X	X	X														X							X	X	X	X	X	X	X				X	
33	NEW TECHNOLOGICAL DEVELOPMENTS	X	X	X	X	X										X	X	X	X	X														X	X	X	X											X	X	X		X	X

* TABULATIONS ARE ABBREVIATED TITLES. SEPARATE LISTINGS ARE PROVIDED FOR PARAMETER GROUP CONTENTS

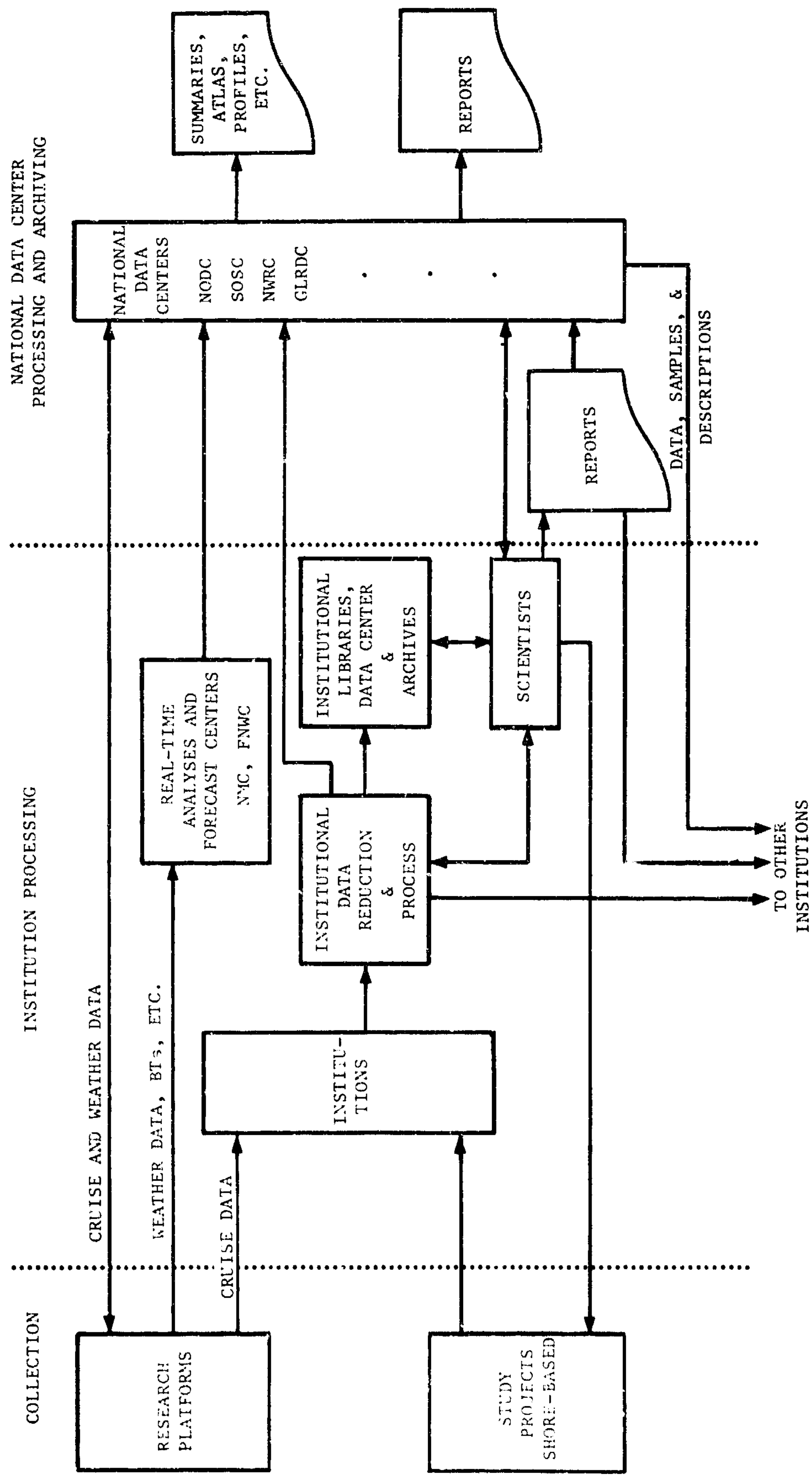


FIGURE II-1. GENERALIZED RESEARCH DATA FLOW

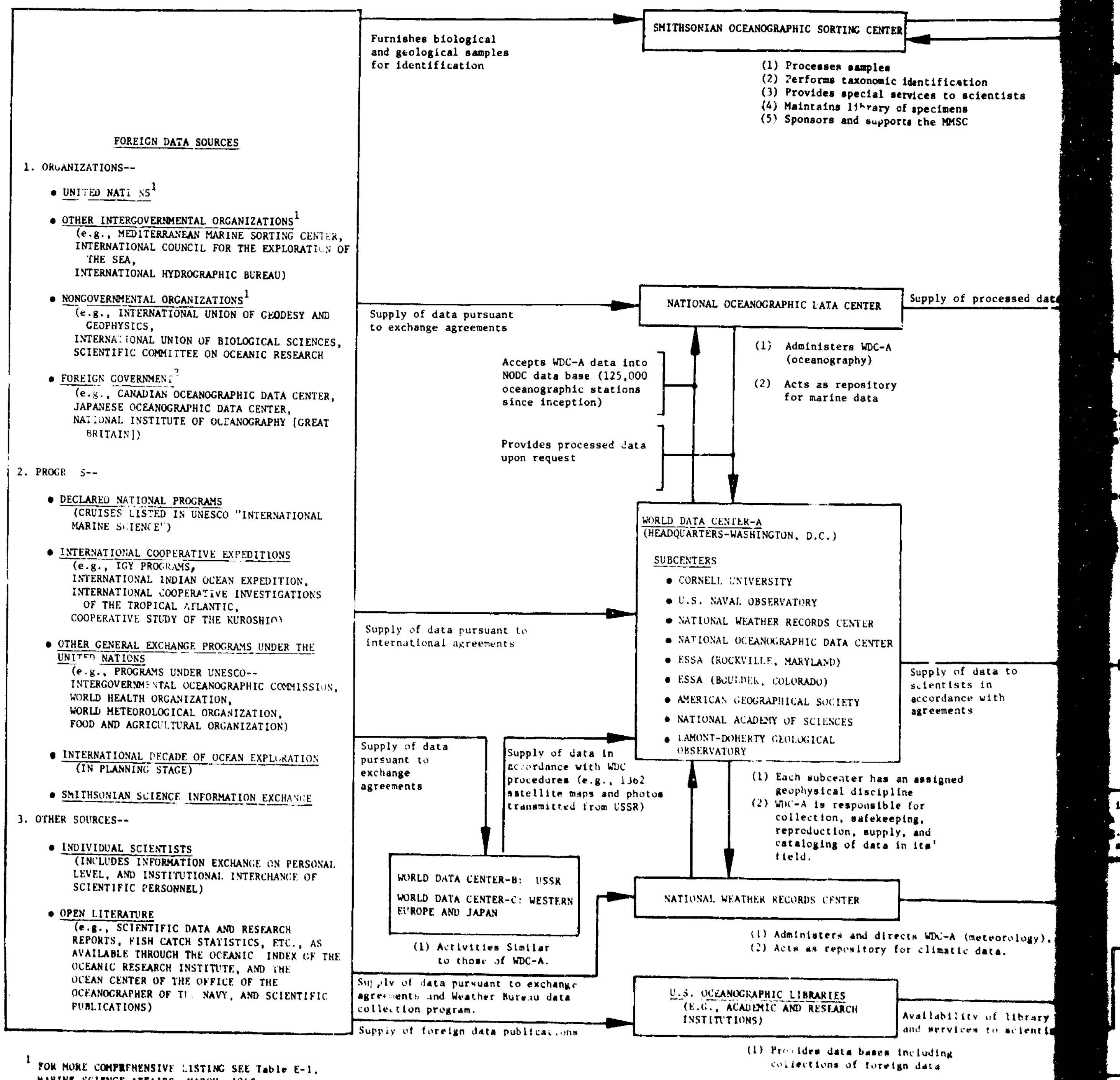
then hand-carried to the investigator's institution, where data reduction and processing take place. (Preliminary reduction and processing may take place onboard in some cases.)

From this point, the flow of cruise data and shore-based project data are similar. The processed data are filed in the institution's library or archives, and/or in the file of the investigator. For some categories processed data (and samples) are transmitted to one of the national archiving centers (e.g., NODC, SOSC, NWRC), and/or disseminated to other interested institutions and investigators.

Processed data are then analyzed by the investigator or project staff. Supplemental data for these analyses may be obtained from the national data centers or from institutional archives. The results of the analyses, and interpretations in the form of reports and papers, are then disseminated to the interested community and, in some cases, to national data centers.

For some types of data, and for all pertinent data collected on some projects or cruises, formalized procedures exist for reduction, processing, analysis, and filing. For the remainder, several years may pass before the data or the analyses receive general dissemination. In some cases, the data are maintained only in the project's or principal investigator's files.

Additional sources of data of major value to research efforts in the United States are international science organizations, foreign agencies, institutions, projects, and scientists. These data are supplied either (1) by individual scientists, (2) through the medium of the open literature, or (3) in conjunction with various exchange agreements. The generalized flow of these data into United States agencies and activities is indicated in Figure II-2.



[1] FOR MORE COMPREHENSIVE LISTING SEE Table E-1, MARINE SCIENCE AFFAIRS, MARCH, 1968.

[2] FOR MORE COMPREHENSIVE LISTING SEE MARINE SCIENCE ACTIVITIES OF THE NATIONS OF 1. AFRICA, 2. LATIN AMERICA, 3. NEAR EAST AND SOUTH ASIA, 4. EAST ASIA, AND 5. CANADA AND THE NATIONS OF EUROPE, APRIL 1968, GPO.

NOTE: Princip
In indi
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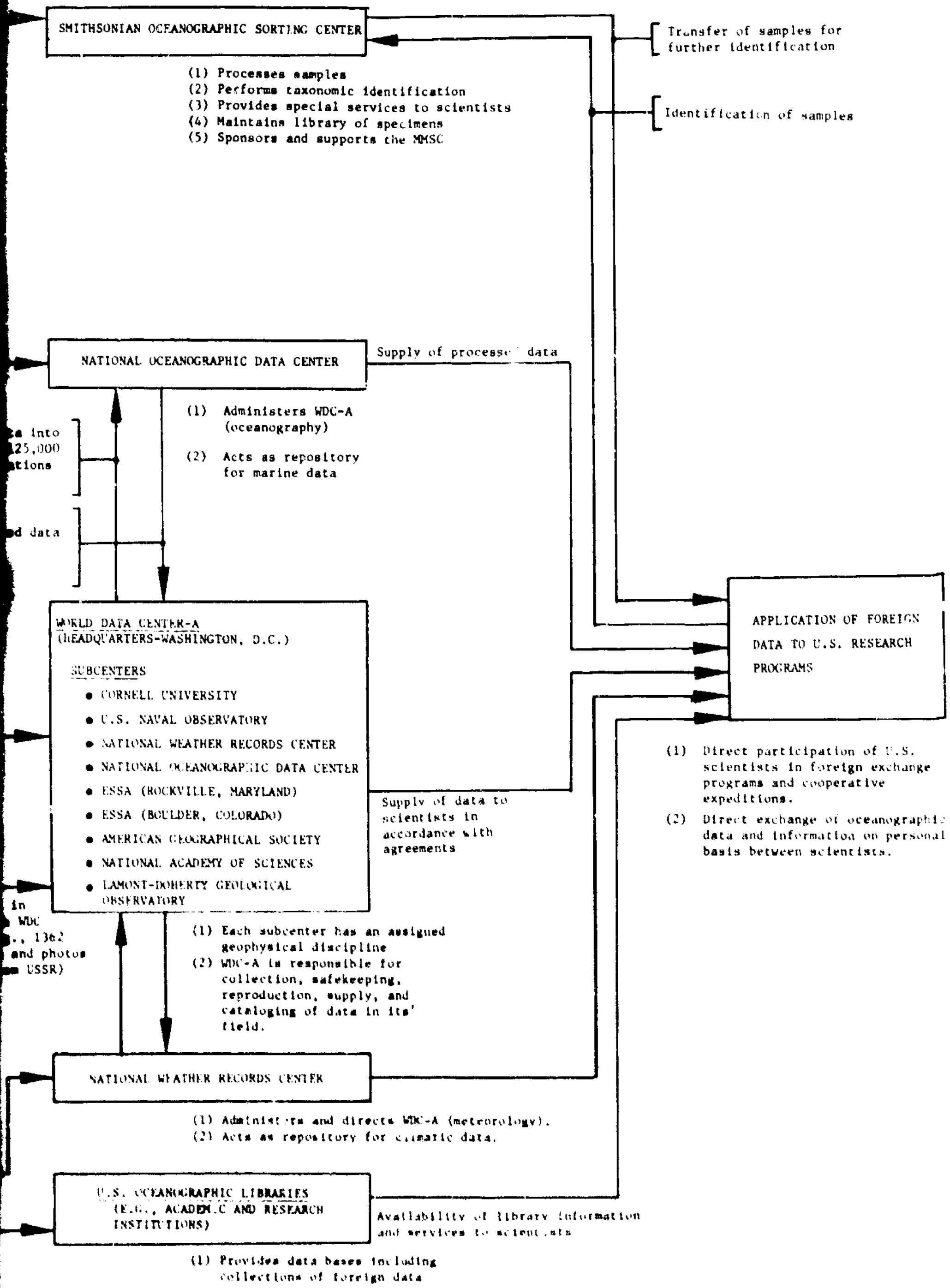
FIGURE II-2. FLOW OF FOREIGN DATA TO U.S. MARINE SCIENTISTS



NOTE: Principal direction of data flow from foreign sources is indicated by the flow lines and arrows. Not indicated here is the flow of data in the reverse direction from data centers to foreign users.

SCIENTISTS

ENVIRONMENTAL FORECASTING DATA FLOW

Environmental forecasting products under consideration include warnings and forecasts of marine and coastal meteorological and oceanographic conditions. Besides normal weather forecasts, these include, but are not limited to, sea state conditions, ocean thermal conditions, breakers and surf, hurricanes or typhoons and storms, storm surges, seismic sea waves, ice and iceberg advisories, tide and tidal current tables, estuarine renewal advisories, and albacore fisheries advisories. As previously described, the timeliness of data flow is critical for all of these products, with the exception of tide and tidal current predictions.

The total environmental forecasting network is dominated by the needs of the weather and sea state forecasting component. This component actually consists of two separate networks, the ESSA-Weather Bureau and the Naval Weather Service Command, which tend to complement each other. The basic elements are the observation stations, the observation transmission network, the analytical (NMC and FLENUMWEACEN) and forecast centers, and the chart and forecast dissemination networks.

Surface observations are normally made on a 3-hour synoptic schedule by 12 Ocean Station Vessels, and on a 6-hour basis by a large number of coastal and island observation stations (U.S. and foreign), from ships at sea (Coast Guard, Navy, merchant, foreign, etc.), and from buoys. Upper air observations are made by the Ocean Station Vessels, selected coastal and island stations, and some of the ships at sea. These data, supplemented by aperiodic in-flight aircraft reports, are transmitted via various commercial and Federal communications networks to the analytical centers for processing. Hemispheric and other large-area analyses and prognoses of surface and upper air conditions are then transmitted to various facilities and units for local tailoring and dissemination to the users. The flow of data for the Weather Bureau and the Naval Weather Service Command is illustrated in Figure II-3 and Figure II-4, respectively.

Satellite information is also used as input for products at the main analytical centers and the dissemination facilities and units. Additionally, localized synoptic charts are sometimes hand-plotted and analyzed at the dissemination facilities and units. Various intermediate products are used in preparing the end products, which are disseminated to the user communities.

The dissemination facilities and units prepare warnings and forecasts of marine meteorological and oceanographic conditions within their areas of responsibility. Many products and forecasts under development are also prepared for local areas. Data flows for these functions include the input of local observations and analyses, and analyses and prognoses from the main analytical centers. Warnings are issued to the interested communities as required, while local weather and recreational surf forecasts are normally issued daily.

Hurricane advisories are prepared and disseminated to the civilian community by the National Hurricane Center in Miami for the east coast, the San Francisco Weather Bureau Office for the Eastern Pacific, and the Honolulu Weather Bureau Office for the Central North Pacific. The Naval Weather Service Command prepares and disseminates all typhoon advisories in the Western Pacific through the Joint Typhoon Warning Center and disseminates hurricane advisories to the U.S. Naval community. Additionally, warnings may be issued by the local dissemination facilities, units, or offices of the Weather Bureau in New Orleans, San Juan, Washington, D.C., and Boston, or those of the Naval Weather Service Command. Data input for these forecasts include numerical and hand-analyses and prognoses, satellite photos, and local observations. For the Weather Bureau these analyses and prognoses are prepared by NMC and the Regional Center for Tropical Meteorology. Satellites, as well as ship and aircraft, are of major importance in detecting and tracking hurricanes. These advisories receive widespread dissemination to all interested parties.

Environmental forecasting products are primary inputs into a number of secondary networks. A major example, ship routing, is indicated in Figure II-5.

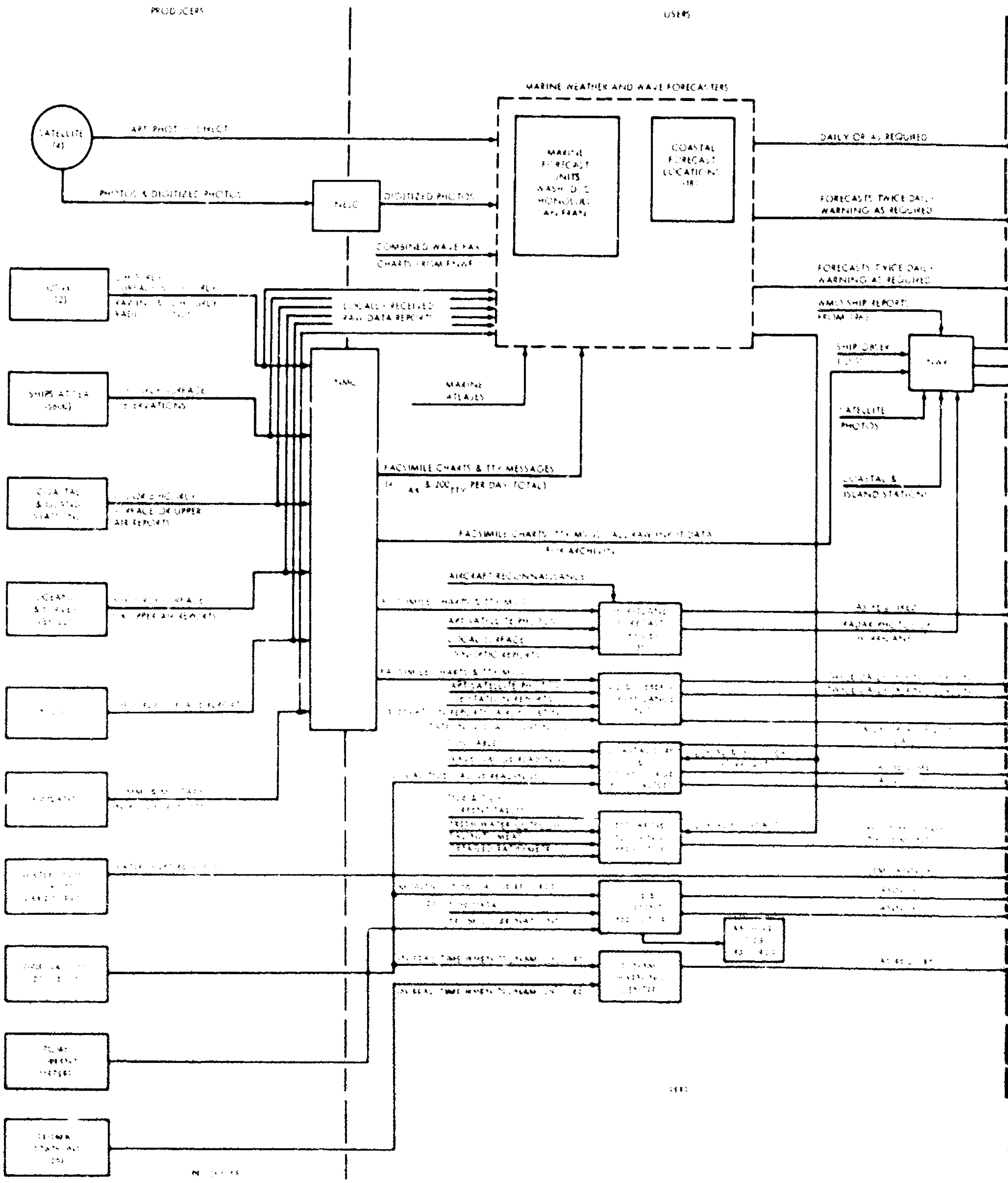
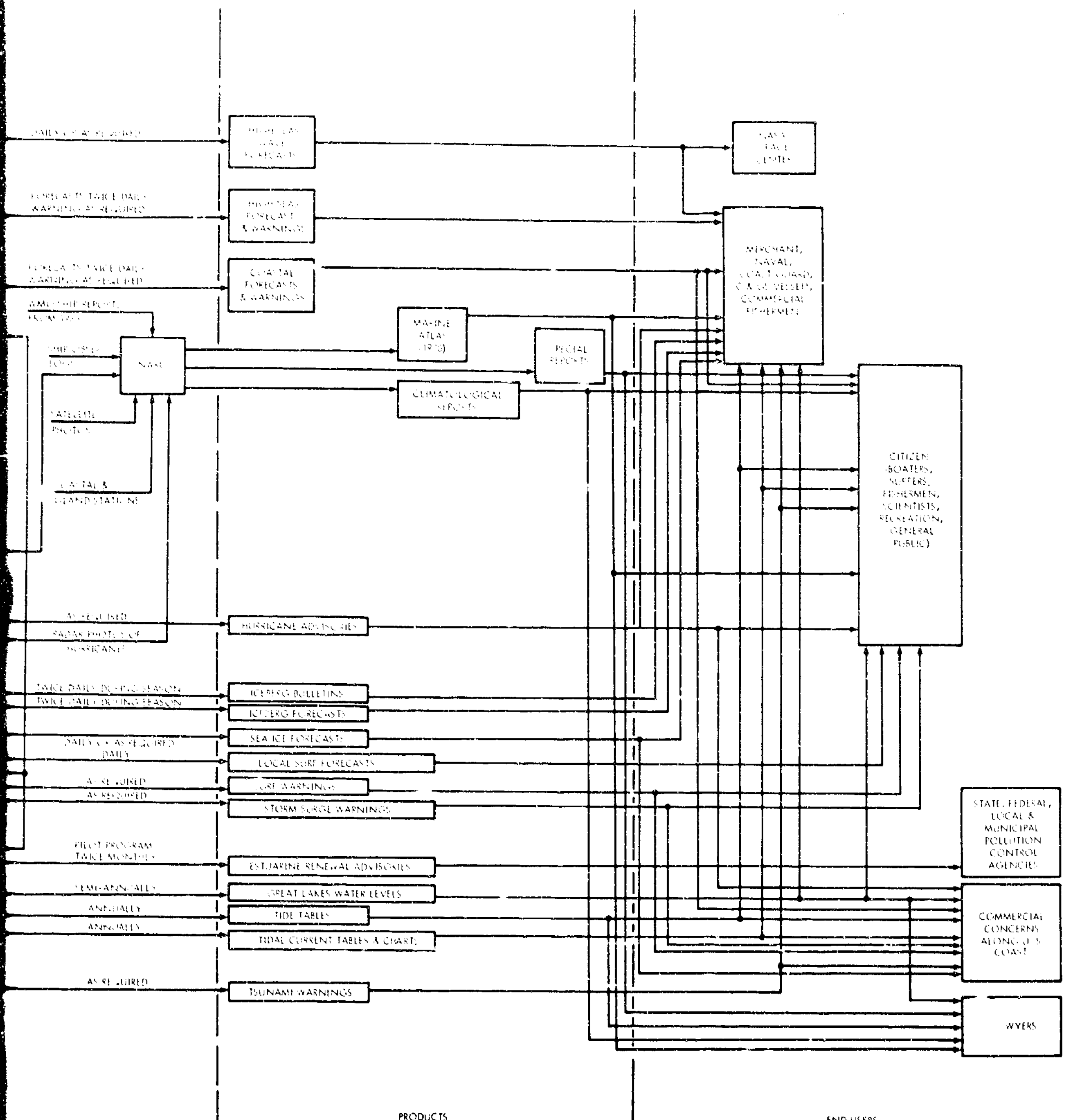
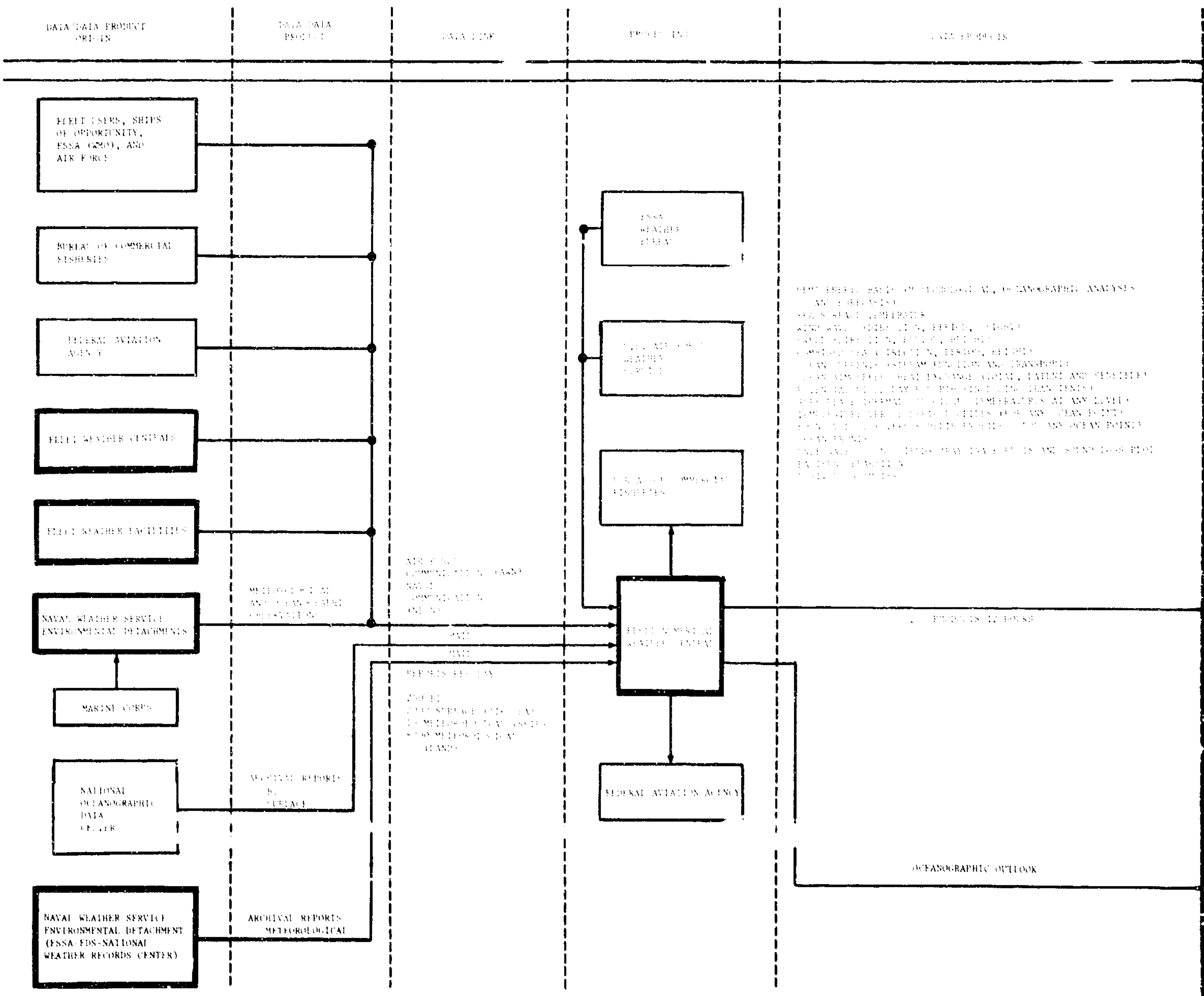


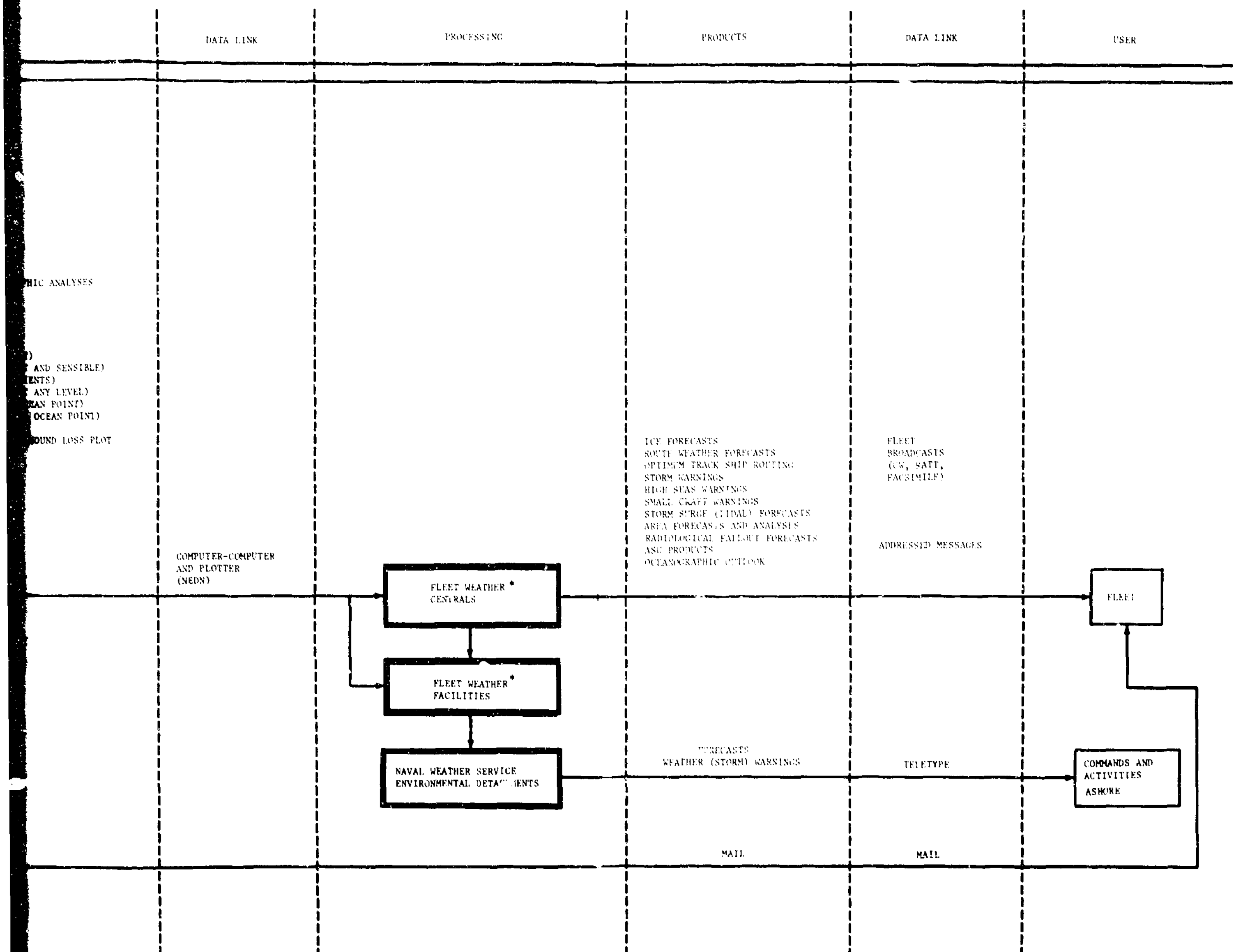
FIGURE II-3. MARINE FORECASTING ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION DATA FLOW



COASTAL FORECASTS & WARNINGS
MARINE ATLAS (1970)
CLIMATOLOGICAL REPORTS
MERCHANT, NAVAL,
CITIZENS (BOATERS, SURFERS, FISHERMEN, SCIENTISTS, RECREATION, GENERAL PUBLIC)
AS REQUIRED
HURRICANE ADVISORIES
TWICE DAILY DURING SEASON
ICEBERG BULLETINS
ICEBERG FORECASTS
SEA ICE FORECASTS
DAILY
LOCAL SURF FORECASTS
STORM SURGE WARNINGS
STATE, FEDERAL, LOCAL & MUNICIPAL POLLUTION CONTROL AGENCIES
PILOT PROGRAM
ESTUARINE RENEWAL ADVISORIES
SEMI-ANNUALLY
GREAT LAKES WATER LEVELS
ANNUALLY
TIDE TABLES
TIDAL CURRENT TABLES & CHARTS
COMMERCIAL CONCERNS
TSUNAMI WARNINGS
PRODUCTS
END USERS



DATA/DATA PRODUCT ORIGIN
FLEET USERS, SHIPS OF OPPORTUNITY, ESSA (WMO), AND AIR FORCE
BUREAU OF COMMERCIAL FISHERIES
FLEET WEATHER CENTRALS
FLEET WEATHER FACILITIES
NAVAL WEATHER SERVICE ENVIRONMENTAL DETACHMENTS
MARINE CORPS
NATIONAL OCEANOGRAPHIC DATA CENTER
NAVAL WEATHER SERVICE ENVIRONMENTAL DETACHMENT (ESSA-EDS-NATIONAL WEATHER RECORDS CENTER)
ARCHIVAL REPORTS METEOROLOGICAL
MAIL
FEDERAL AVIATION AGENCY
OCEANOGRAPHIC OUTLOOK



NOTES

NAVAL WEATHER SERVICE UNITS IN DARK OUTLINE.

*LOCAL BLOW-UP OF HEMISPHERIC PRODUCTS FROM FLEET NUMERICAL WEATHER CENTRAL.

FIGURE II-4. MARINE FORECASTING - NAVAL WEATHER SERVICE COMMAND DATA FLOW

Optimum Track Ship Routing requires accurate long-range forecasting of meteorological and sea state conditions. The various analyses and prognoses utilized are produced by the main analytical centers. Commercial routing services use Weather Bureau products to derive optimum tracks, while the Naval Weather Service Command's Fleet Weather Centrals in Norfolk and Alameda use FLENUMWEACEN and NAVOCEANO products for routing military vessels. The routing information is then transmitted by various means to ships in port or at sea. (Route revisions, when necessary, are transmitted to vessels at sea.)

The Naval Weather Service Command also produces unique oceanographic products used primarily for military naval operations, including submarine and anti-submarine operations. The data input include meteorological analyses and prognoses and some 250 daily BT observations from ships at sea. Products include descriptions and forecasts of vertical and horizontal ocean thermal structure, sound velocity, ocean fronts, sea and swell height, and other related products. These products are disseminated through the Fleet Weather Centrals and Facilities to fleet and shore activities.

Tide and tidal current tables and charts are prepared annually by the Coast and Geodetic survey from data acquired from a worldwide network of tide gauges and from tide and current data acquired by survey vessels. An estuarine flushing and nontidal current prediction service has been established for the Penobscot River and Bay estuary in Maine as a pilot project. The program is designed to provide a service to Federal, State, county, and municipal agencies and private industries. Specifically, the service is made available to the U.S. Federal Water Pollution Control Administration, Fish and Wildlife Service, Public Health Service, Atomic Energy Commission, Geological Survey, Maine Department of Sea and Shore Fisheries, University of Maine, and paper companies. These organizations may use the predictions to assist in: industrial effluent discharge control, industrial and potable intake regulation, determination of sewage and industrial waste treatment requirements, recreation planning, planning of industrial and residential development, the protection of public health, and the protection of fisheries.

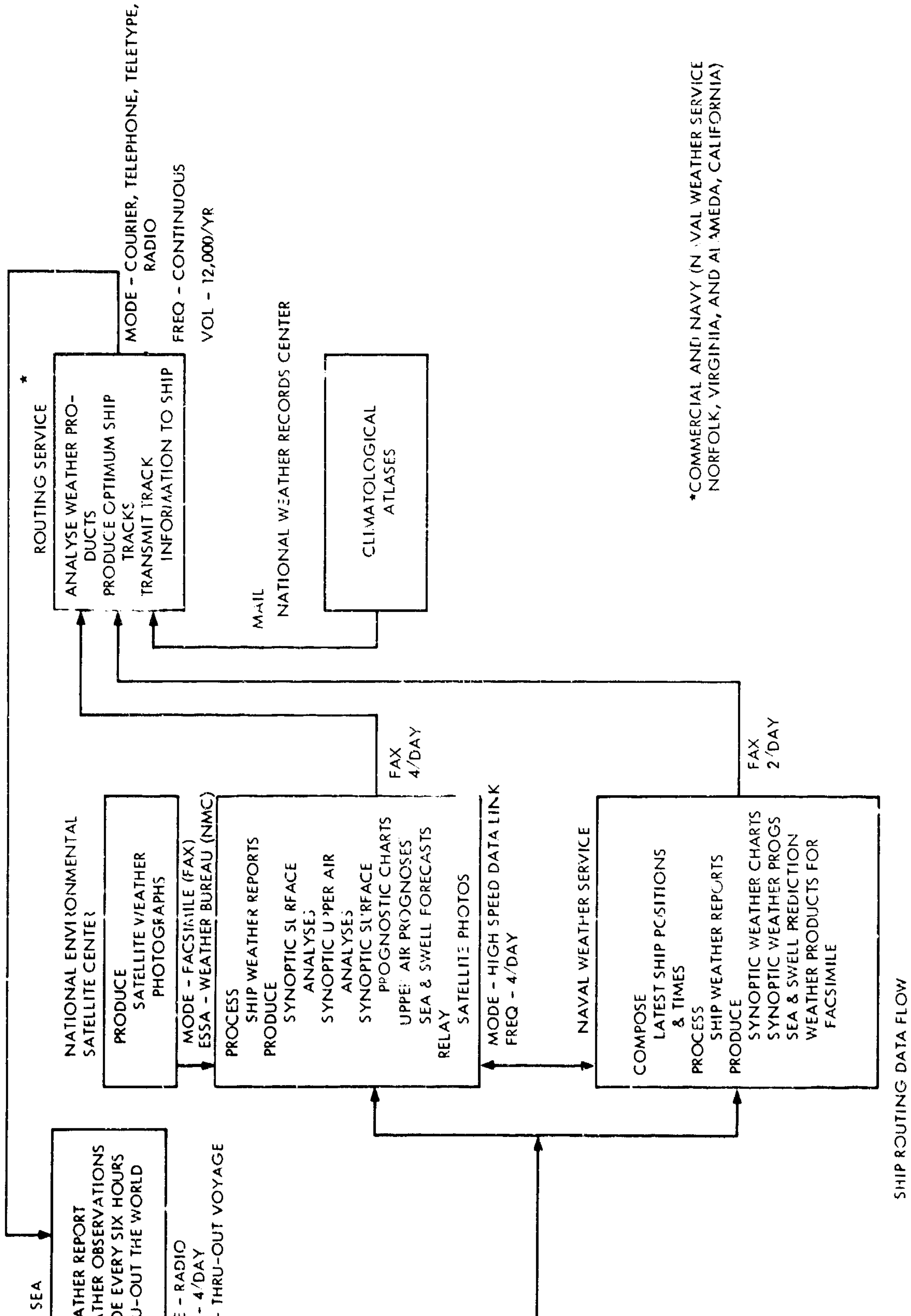


FIGURE II-5. SHIP ROUTING DATA FLOW

Tsunami warnings are prepared as required for the Pacific region by the C&GS Tsunami Warning Center in Honolulu. The data input consist of reports from a network of seismic monitoring stations and data from tide stations in the Pacific area.

The nature of the C&GS products are quite different; the tide and tidal current products are long term and are published annually; estuarine flushing predictions are prepared twice monthly; and the tsunami warnings are prepared as required. The data flow networks are therefore largely independent of the environmental forecast dissemination networks.

Iceberg bulletins are produced by the U.S. Coast Guard. Input data include the NMC analyses and prognoses, satellite photos, reports from a network of ice stations, observations from USCG patrol vessels and aircraft, and other visual observations. These products are prepared only for the North Atlantic region, and dissemination is made to all commercial and military vessels.

The albacore fishery advisory is prepared by the U.S. Bureau of Commercial Fisheries in La Jolla, California. The preparation of this product requires the acquisition of several types of data from different sources. The data flow is illustrated in Figure II-6. The advisories are issued in daily radio broadcasts to the albacore fishing fleet containing information on sea surface temperature, weather and sea state, and current catch data. Sea surface temperature (SST) data are transmitted by FLENUMWEACEN via data lines to a plotter at BCF, La Jolla, where SST temperature charts are produced on-line. SST data are also received from the fishing fleet and other vessels operating in the fishing area. Weather forecasts and catch data are received from the Weather Bureau (San Francisco) and FLENUMWEACEN. Catch data are also received directly by BCF, La Jolla. These data and forecasts are then incorporated into the broadcast advisory. BCF, La Jolla, also prepares monthly and 15-day SST charts, an annual albacore abundance forecast, and special bulletins as required. Fishery abundance forecasts are prepared annually at various BCF laboratories for a number of commercial species.

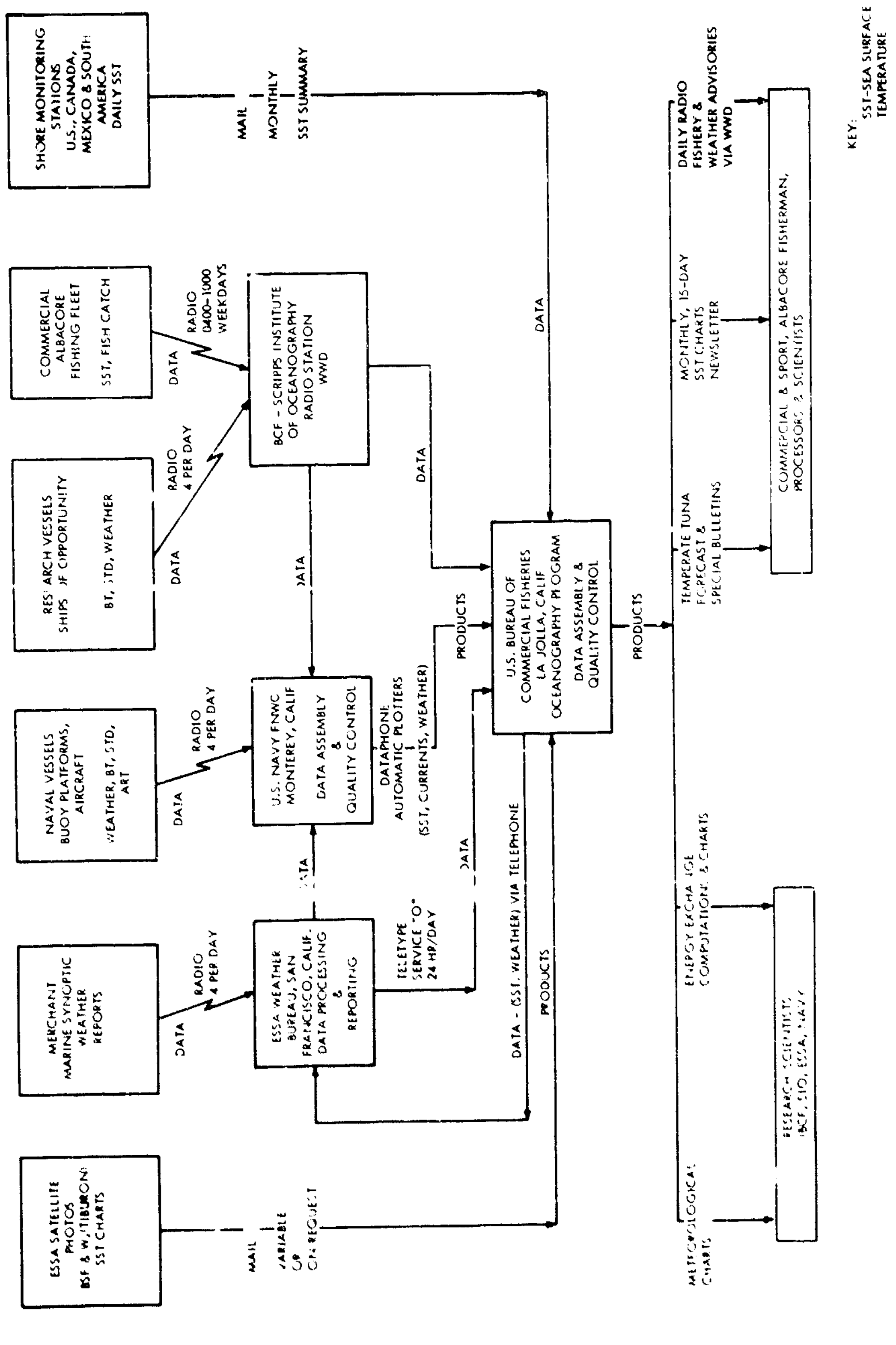


FIGURE II-6. BUREAU OF COMMERCIAL FISHERIES - ALBACORE FISHERY

ENVIRONMENTAL DESCRIPTION PRODUCTS DATA FLOW

Categories of Products

Environmental description products include historical marine environmental summaries (e.g., climatological and oceanographic atlases), topographic (bathymetric) maps, navigational products, geological/geophysical maps and atlases, biological and fisheries products, ocean engineering products, pollution and water quality reports, and other miscellaneous reports, atlases, and summaries. The historical products are based on the accumulation of data for a subject area during an extended period of time. Nonhistorical descriptive products are based on the collection of extensive data within the subject area. Archiving and storage and retrieval systems are essential for handling the large quantities of accumulated data. Except for a few special cases, real-time data are of no importance in the preparation of these products, and timeliness is measured in months, rather than hours.

The responsibility for preparing the various products are distributed among several government agencies, based on (1) the geographic area covered, and (2) the discipline. The descriptive product activities of the various agencies are indicated in Table II-2. From this table it is evident that NAVOCEANO has the major responsibility for providing products with worldwide coverage, and that the Lake Survey has the major responsibility in the Great Lakes region. For domestic waters, including the U.S. continental shelves, a majority of the products are provided by the Coast and Geodetic Survey; however, the dominance is not as great as in the other two geographic areas.

The Bureau of Commercial Fisheries (and BSF&W) has sole responsibility for providing fisheries products, and also produces several nonbiological descriptive products of direct pertinence to fisheries operation. The USGS has major, but not exclusive, responsibility for producing marine geological and geophysical products. The six other agencies indicated also have specific, limited responsibilities in descriptive product preparation.

TABLE II-2
ENVIRONMENTAL DESCRIPTION PRODUCTS AND PRINCIPAL FEDERAL PRODUCERS

ENVIRONMENTAL DESCRIPTION PRODUCTS	GREAT LAKES	U.S. CONTINENTAL SHELF	WORLDWIDE
MARINE HISTORICAL ENVIRONMENTAL PRODUCTS			
CLIMATOLOGICAL ATLASES	EDS (B)	EDS (B)	EDS (B) NAVOCEANO (C)
SEA AND SWELL ATLASES	EDS (C)	CERC* (B)	NAVOCEANO (A)
SEA SURFACE TEMPERATURE ATLASES	LAKE SURVEY (B) BCF (C)	BCF (C)	NAVOCEANO (A) BCF (C)
SURFACE CURRENT ATLASES	LAKE SURVEY (C) FWPCA (C)	C&GS (C) CERC* (C)	NAVOCEANO (A)
ICE ATLASES	LAKE SURVEY (B)		NAVOCEANO (A)
OCEAN STATION ATLASES	LAKE SURVEY (B) BCF (C) FWPCA (C)	C&GS (B) BCF (C), CG (C)	NAVOCEANO (A)
PILOT CHARTS			NAVOCEANO (A)
BATHYMETRIC MAPS AND CHARTS		C&GS (A) BSF&W (C) USGS (C) ERL (C)	NAVOCEANO (A) ERL (C)
NAVIGATIONAL PRODUCTS			
NAUTICAL CHARTS	LAKE SURVEY (A)	C&GS (A)	NAVOCEANO (A)
NAVIGATION NOTICES	CG (A)	CG (A) NAVOCEANO (A)	NAVOCEANO (A)
TIDE TABLES (ASTRONOMIC)	NOT APPLICABLE	C&GS (A)	C&GS (A) NAVOCEANO (C)
TIDAL CURRENT TABLES AND CHARTS	NOT APPLICABLE	C&GS (A)	C&GS (C) NAVOCEANO (C)
NAVIGATION TABLES AND PUBLICATIONS	NAVOCEANO (A)	C&GS (C) NAVOCEANO (A)	NAVOCEANO (A)
NAVIGATION SUPPLEMENTS	CG (A) LAKE SURVEY (A)	C&GS (A) CG (A)	NAVOCEANO (A)
NAUTICAL ALMANACS AND EPHEMERIDES	NAVAL OBSERVATORY (A)	NAVAL OBSERVATORY (A)	NAVAL OBSERVATORY (A)
GEOLOGICAL AND GEOPHYSICAL PRODUCTS			
MAGNETIC FIELD MAPS	C&GS (C)	C&GS (B) NAVOCEANO (C) ERL (C)	NAVOCEANO (A)
GRAVITATIONAL FIELD MAPS		C&GS (B), ERL (C) NAVOCEANO (C)	NAVOCEANO (B) ERL (C)
GEOLOGICAL MAPS	USGS (C) COE (C) LAKE SURVEY (C)	USGS (B), ERL (C) CERC* (C), BCF (C)	NAVOCEANO (A) ERL (C)
GEOLOGICAL AND GEOPHYSICAL REPORTS	USGS (C) LAKE SURVEY (C)	USGS (B), ERL (C)	NAVOCEANO (C) USGS (C)
FISHERY PRODUCTS			
FISHERY STATISTICS REPORTS	BCF (A)	BCF (A)	BCF (A)
FISHERY RESOURCE ATLASES	BCF (C)	BCF (B)	BCF (B)
SPORT FISHING ATLASES	BSF&W (A)	BSF&W (A)	
METEOROLOGICAL REPORTS (EXCEPT CLIMATOLOGICAL ATLASES)	WB (A) ERL (C) EDS (A)	WB (A) ERL (C) EDS (A)	WMO (A), ERL (C) WB (C) NAVWEASERV (C)
WATER QUALITY AND POLLUTION CONTROL REPORTS	FWPCA (B)	FWPCA (B)	
CRUISE AND DATA REPORTS	ALL AGENCIES	ALL AGENCIES	ALL AGENCIES

* Coastal (shoreline) only.

(A) Producer is presently maintaining products for geographic areas presently completely covered or is compiling the additions necessary to achieve complete geographic coverage.

(B) Producer presently has coverage of selected areas and has plans for complete geographic coverage.

(C) Producer presently has coverage of only selected areas.

NAVOCEANO

NAVOCEANO produces environmental description products on a worldwide basis. All types of standard products are included except those relating to fisheries. Magnetic field maps, gravitational field maps, and navigation notices are also produced for selected areas in the U.S. continental shelves.

The general flow of data related to the production of these diverse products is indicated in Figure II-7. The central elements in the data flows pertinent to the specific products are the data holdings maintained in operational files. These data are acquired from various sources. For example, marine climatological analyses are acquired from NWRC and, in conjunction with NWRC, NAVOCEANO produces and maintains the pilot chart series, sea and swell charts and atlases, and SST atlases (inputs to NWRC are indicated in Figure II-3); ocean station data, including BT data, are obtained from NODC files, and these data are used to produce ocean station atlases, thermocline depth charts, and sound velocity atlases; the data holdings required for the production and maintenance of ice atlases are obtained from USCG ice and iceberg reports, foreign reports of port and sea ice, NAVOCEANO and other Navy vessels, and NESC ice cover photographs. The sources of other types of data, and the products produced from the accumulated data holdings, are indicated in the flow chart.

Lake Survey

Products currently prepared or planned by the Lake Survey include water temperature charts, survey sheets and nautical charts, water level predictions, nearshore wave charts, surface current charts, ice charts, bottom sediment charts and the Great Lakes Pilot.

The data flow for products produced by the Lake Survey is indicated in Figure II-8. Ships and stations operated by the Lake Survey and Canadian governmental agencies are major sources of data. These data are supplemented by those acquired from other Federal agencies with more limited interests, and from non-Federal agencies.

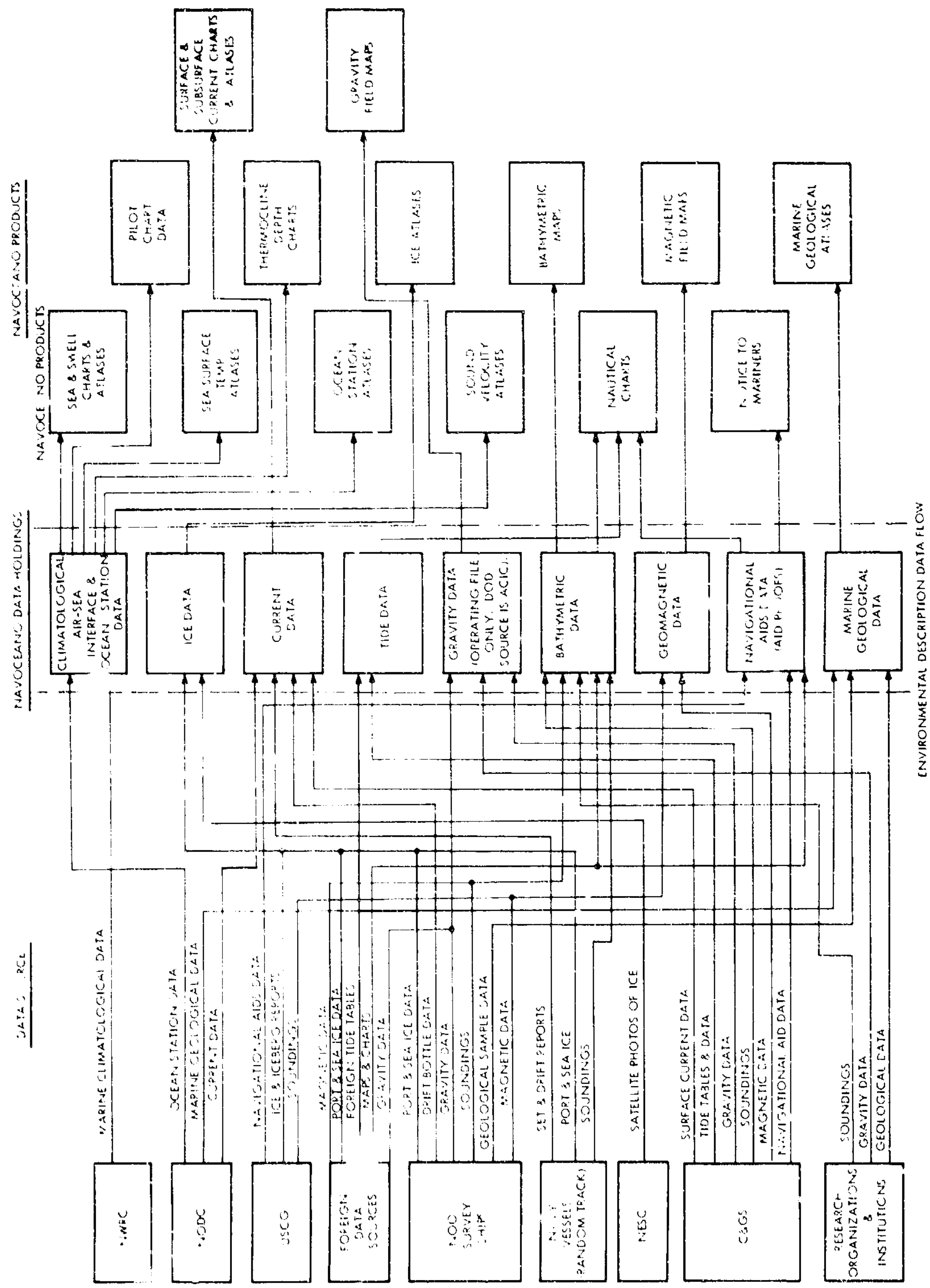


FIGURE II-7. ENVIRONMENTAL DESCRIPTION DATA FLOW (NAVOCEANO)

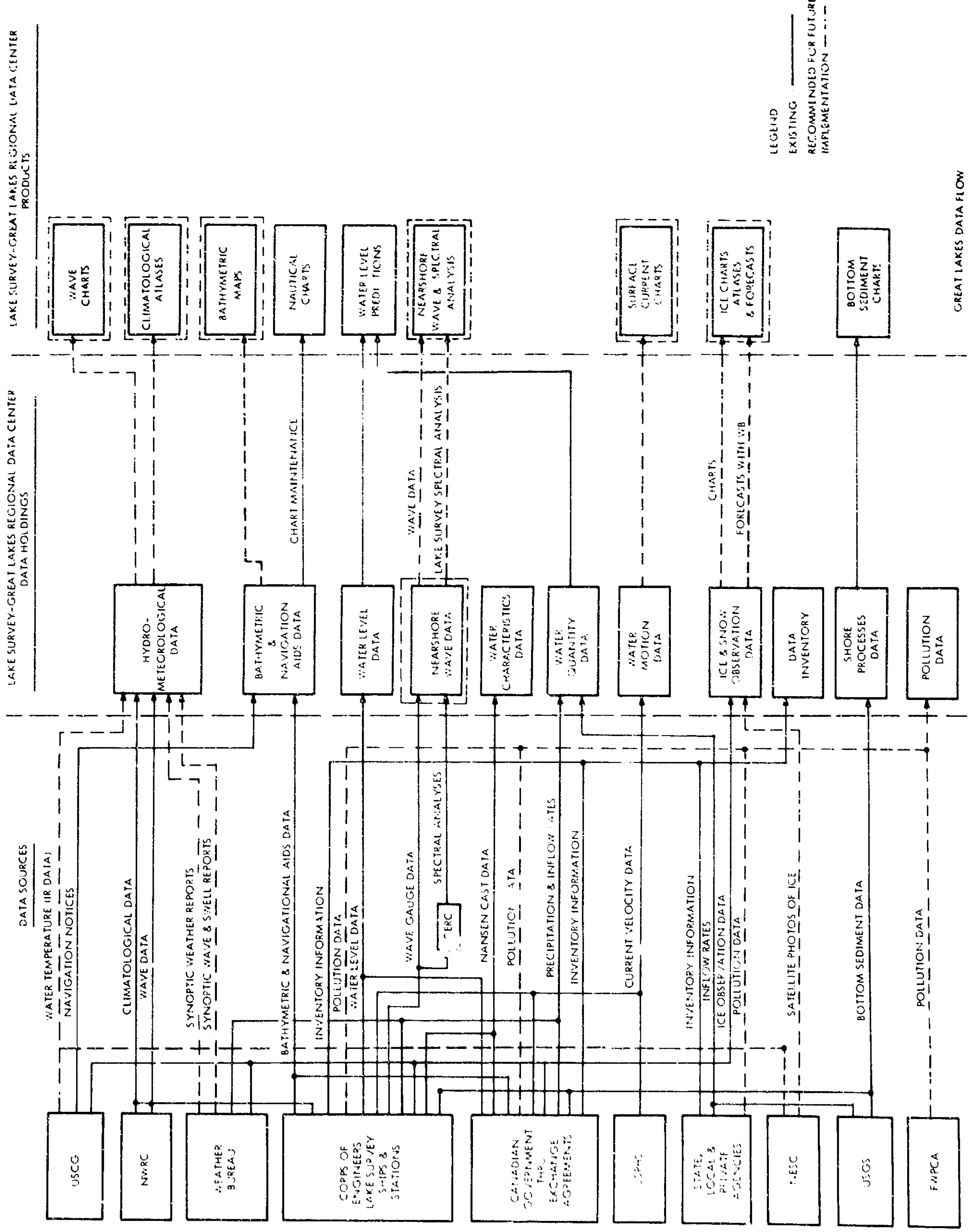


FIGURE II-8. GREAT LAKES DATA FLOW

In addition to the products currently prepared, there are existing plans to produce some new products, and there are user requirements for other new products. Some of these new products can be prepared from existing data holdings and inputs, while others will require supplemental or expanded holdings. Sources currently exist for these additional inputs. The planned and desired new data flows and products are indicated in the flow diagram.

Coast and Geodetic Survey

C&GS has a major responsibility for the preparation of descriptive products in the U.S. coastal and continental shelf zones. These products include surface current charts, water column properties products, bathymetric maps, hydrographic survey sheets, nautical charts, magnetic field maps, gravitational field maps, and other geological/geophysical products.

With the exception of nautical charts, the geographic coverage of the continental shelves is not complete. Current operations of the C&GS will result in the collection of data required for the preparation of some of these products, and plans exist to obtain the data required for the preparation of other products. Products for which the geographic coverage will be completed are the water column properties products, bathymetric maps, and geophysical maps. These data are collected during surveys from C&GS vessels or by field parties.

A major activity of the C&GS is the revision of nautical charts. The data flow typical of chart maintenance activities is indicated in Figure II-9. The data collected during the survey is incorporated into a boat sheet, a working chart. Following the survey, a smooth sheet is prepared, reviewed, and unified. This smooth sheet, in conjunction with pertinent data from other sources, is used to prepare a revision of the standard nautical chart. The revised chart is then published and disseminated to the various users. The time period required from data collection to revised chart dissemination may exceed three years.

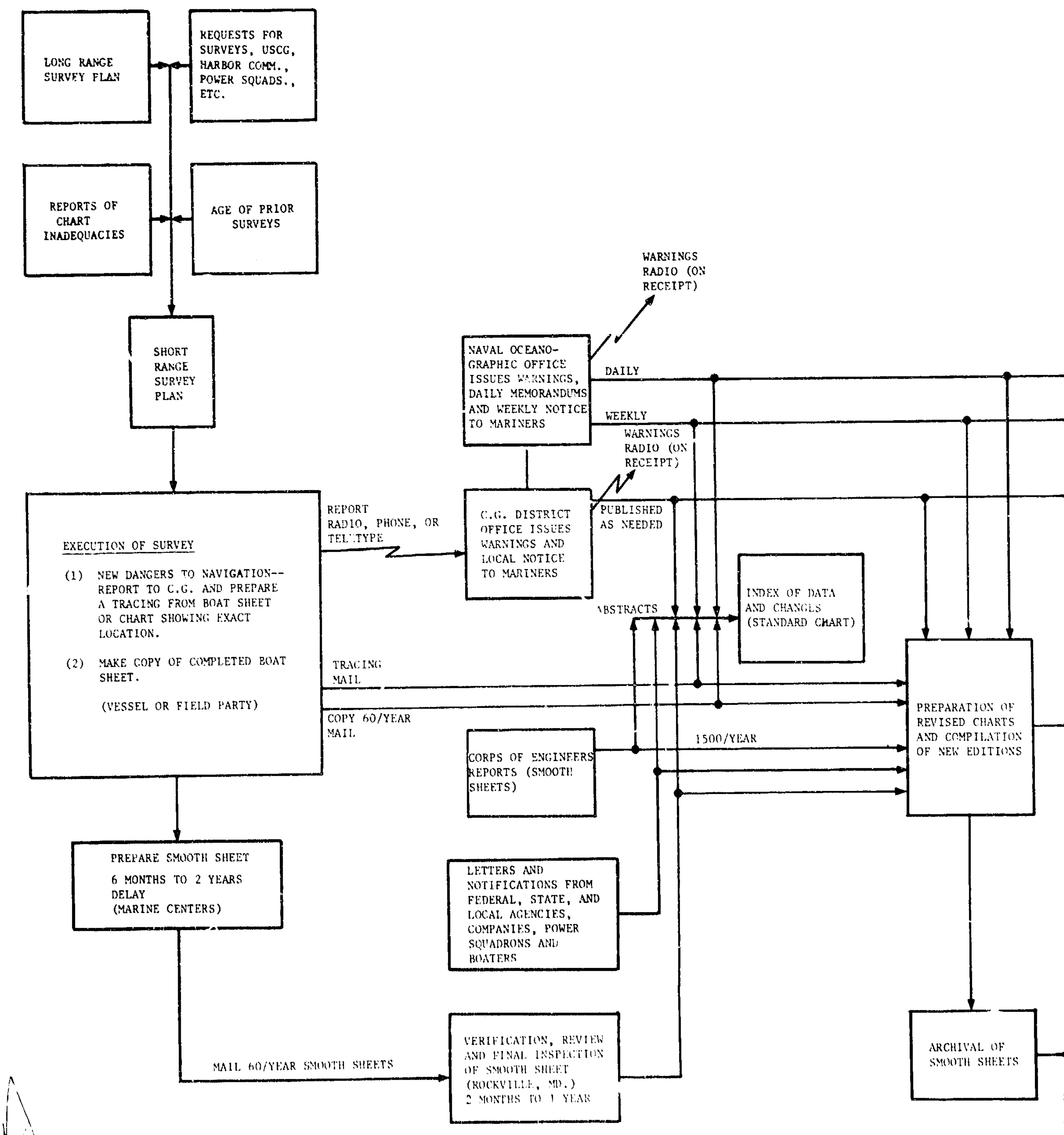
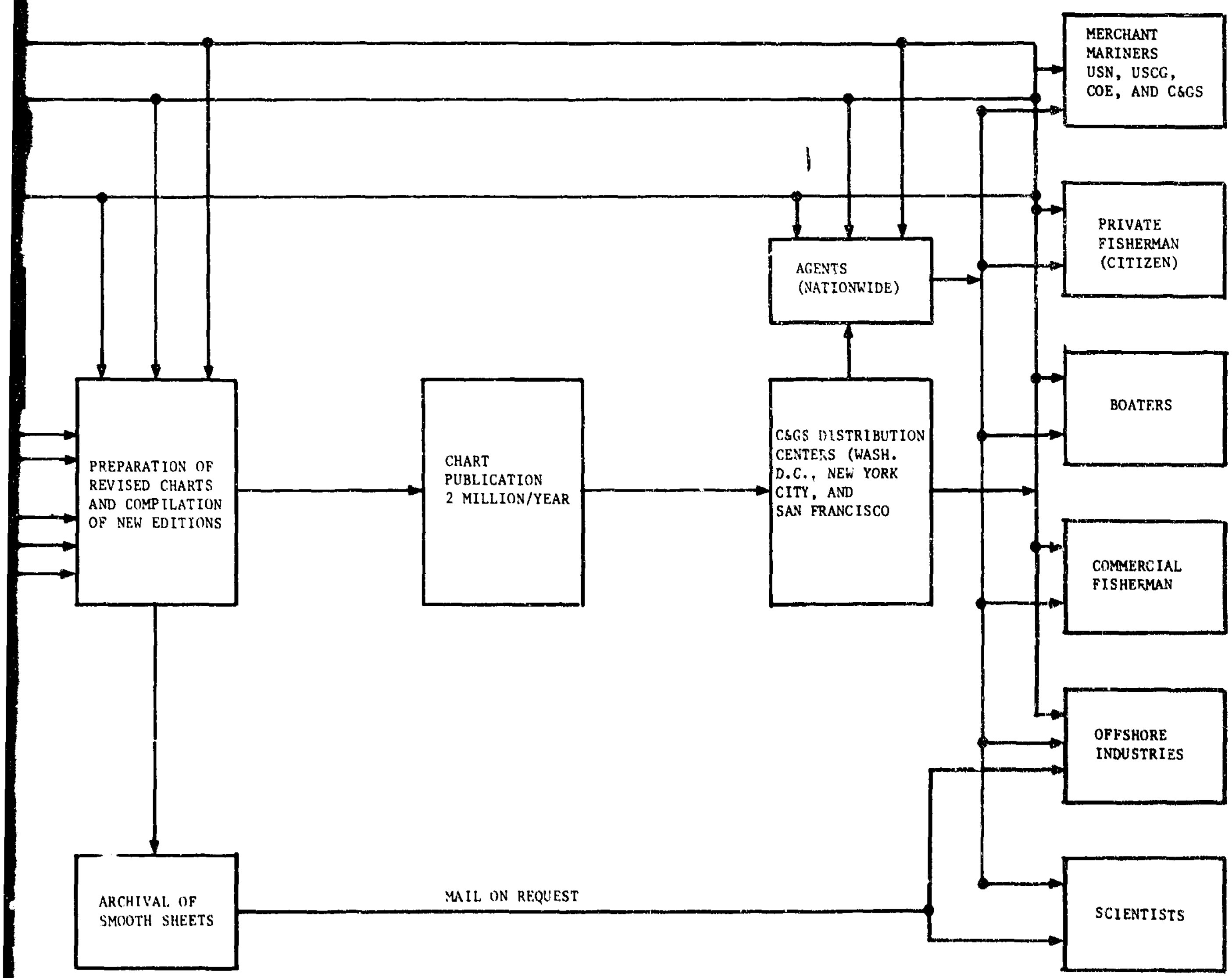


FIGURE II-9. HYDROGRAPHIC DATA FLOW


MERCHANT MARINERS USN, USCG, COE, AND C&GS
PRIVATE FISHERMAN (CITIZEN)
AGENTS (NATIONWIDE)
BOATERS
PREPARATION OF REVISED CHARTS AND COMPILATION OF NEW EDITIONS
CHART PUBLICATION 2 MILLION/YEAR
C&GS DISTRIBUTION CENTERS (WASH. D.C., NEW YORK CITY, AND SAN FRANCISCO
COMMERCIAL FISHERMAN
OFFSHORE INDUSTRIES
ARCHIVAL OF SMOOTH SHEETS
MAIL ON REQUEST
SCIENTISTS

Other Agencies and Products

The generalized data flows described for NAVOCEANO, the Lake Survey, and C&GS are typical of agencies that produce environmental description products. Other such agencies are BCF, USGS, COE, CERC, ERL, and the Coast Guard (Table II-2). Each of these agencies has a defined area of interest; i.e., BCF provides fisheries and related products; USGS produces geological maps and other geological/geophysical products; COE and CERC produce products related to engineering activities on the coast, waterways, harbors, etc.; ERL produces geological/geophysical products for selected areas; and the USCG provides several products related to navigation. Other institutions, including WHOI and the Lamont-Doherty laboratories, also produce other specific major types of products.

ARCHIVING DATA FLOW

The major marine data archiving services are the National Weather Records Center, the National Oceanographic Data Center, the Great Lakes Regional Data Center, and the Smithsonian Oceanographic Sorting Center. Each of these centers provides storage and retrieval and archiving services for data pertaining to discrete subject areas. NWRC provides data services for meteorological and related hydrological data (including both continental and marine data). NODC is being developed to provide a service for diverse categories of marine data. Some of these data are duplicates from various NAVOCEANO files, while the remainder are derived from diverse sources. The Great Lakes Regional Data Center provides services for various categories of data, all pertaining to the Great Lakes region. SOSC provides a service specifically designed for marine biological data and bottom sample information.

These data services are currently in various stages of development in attempts to meet the continually growing demand for both storage and retrieval and archiving. The generalized data flow for the GLRDC has been indicated in Figure II-8. The data input and files are indicated in the flow diagram.

Data input to the NWRC include surface synoptic data, upper air data, radar reports, hydrology data, processed meteorological data, and satellite data. The majority of these data are derived from continental observations. The flow of surface synoptic data from ship observations is illustrated in Figure II-10. A generalized flow diagram for NODC would have the same basic pattern as that indicated in Figures II-8 and II-10, except that the originating sources would be more diverse.

The problem faced by all of the data centers is to continue to develop methods, procedures, and facilities for effective and efficient storage of continually growing volumes of data, and to develop methods of retrieval that will meet the needs of the rapidly growing user communities. These problems are central to the development of a marine data management program.

DESIGN AND DEVELOPMENT DATA FLOW

Ocean engineering design and development activities require diverse types of information from a diversity of sources. The sources and applications of information in a design effort are indicated in a generalized scheme in Figure II-11. Sources of both engineering and environmental data are included. As indicated, some of these sources are not currently utilized as effectively as they could be if better procedures for informational exchange existed. All of these data types would not necessarily be required for a particular design effort. The extensive Naval Ocean Engineering Program, previously described, is in large measure self sufficient, not only as a result of its in-house capabilities, but also because it includes facilities and operations that directly utilize private industrial contractors and academic personnel. However, these informational capabilities are not necessarily readily available for industrial ocean engineering activities.

At the present time, data derived from NODC and NWRC files are not effectively used by the ocean engineering community, nor do these files include some

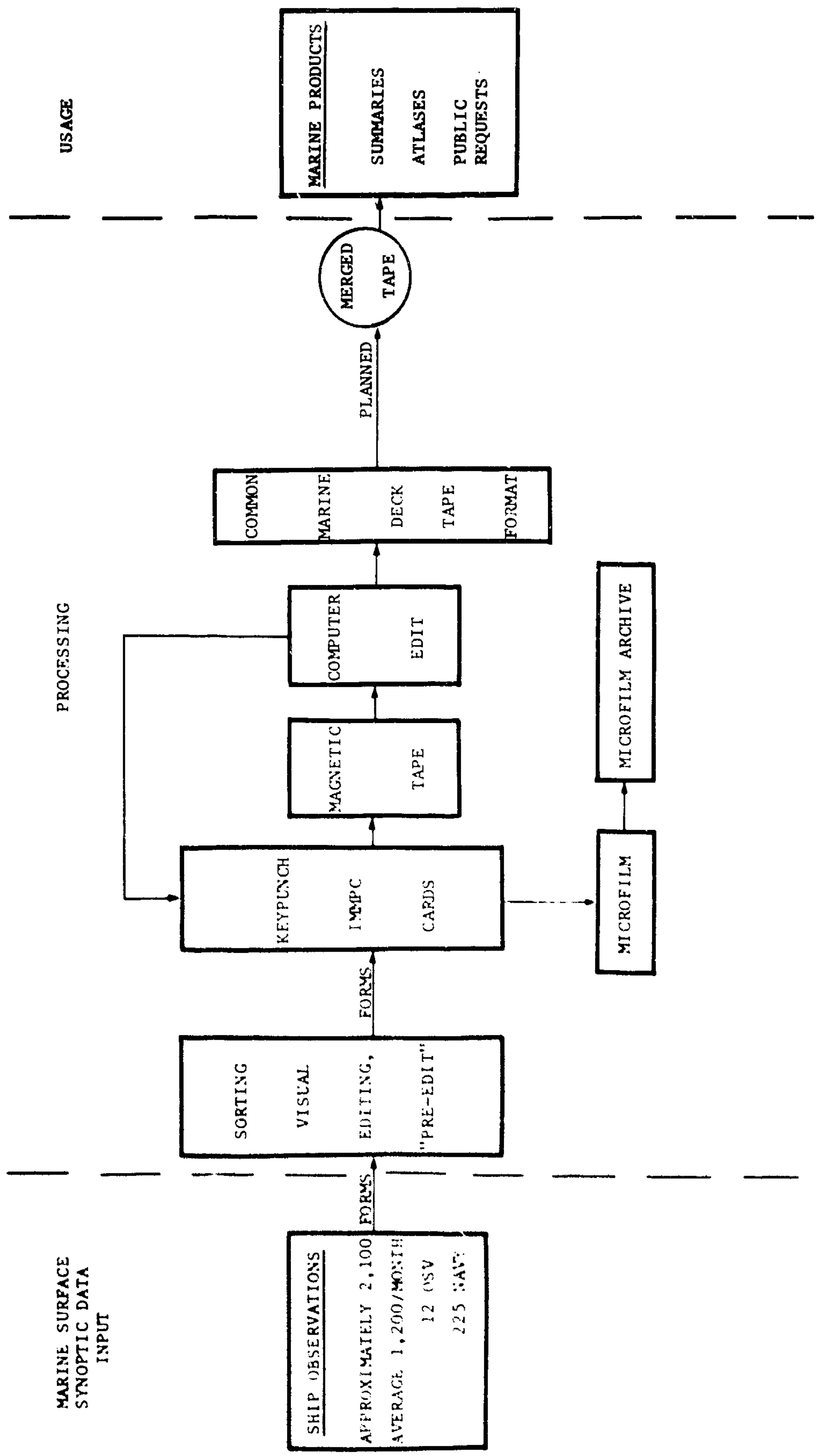


FIGURE II-10. NATIONAL WEATHER RECORDS CENTER - MARINE SURFACE OBSERVATION DATA FLOW

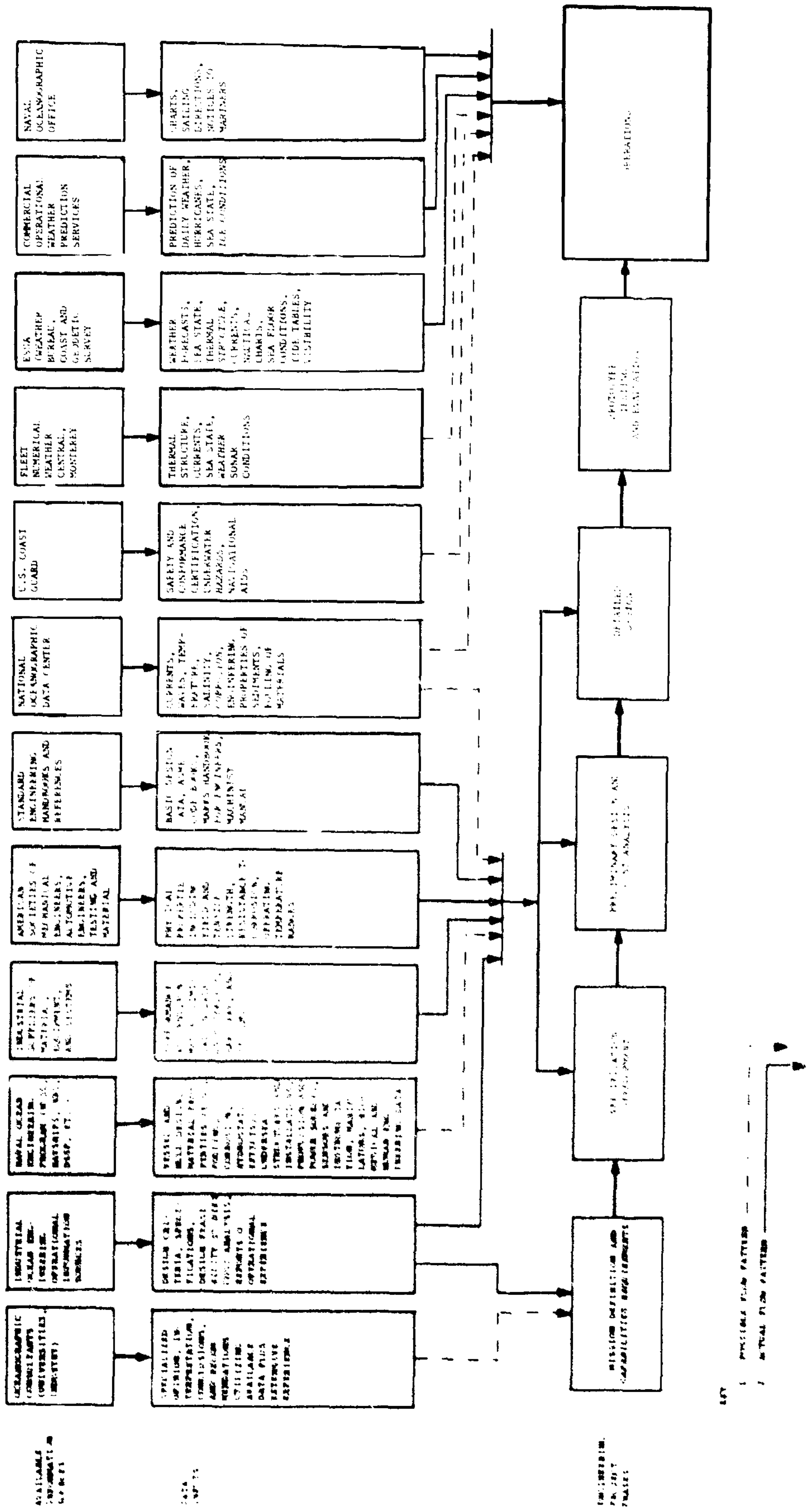


FIGURE II-11. DESIGN AND DEVELOPMENT OCEAN ENGINEERING DATA FLOW

required types of data. Part of the design data flow problem is the result of the proprietary and classified nature of some data; a part is the result of the lack of information exchange on a formal organized basis; and a part is the result of the rapid proliferation of data. An effective ocean engineering data service will be required in order to resolve the data flow problem.

CHAPTER III

ANALYSIS OF CURRENT AND FUTURE REQUIREMENTS

DATA REQUIREMENTS

EXISTING DATA BASES

A large part of the marine data collected during recent years, and currently being collected, is filed in storage, retrieval, and archiving systems maintained by various governmental agencies and other organizations. Since these agencies have defined and limited responsibilities, most of the systems have been developed to provide services based on a data base that is restricted to a particular subject area, and the system often functions principally to serve the internal needs of the particular agency. The principal exceptions are the NODC in the area of general oceanography, the NWRC in meteorology, and the SOSC in the biological/geological sample area. These agencies function as data services supporting the activities of other agencies as well as public and private institutions.

Some of the major agencies that maintain marine data bases are indicated in Table III-1. This table includes those data service organizations contacted during the Part II study. The parameter groups included in the data bases of the respective agencies are indicated in the table; however, the volume of data in the files, the specific data included, and the availability of the stored data are not indicated. Most of these data are collected for ultimate use in the preparation of specific data products. The remainder are required for research, planning and management, design and development, and environmental monitoring purposes.

More detailed descriptions of the data bases maintained by the various agencies contacted during the Part II study are included in Table III-2. This table includes, by agency, a brief description of the data bases, the specific data

TABLE III-1
SOURCES OF MARINE DATA

	PHYSICAL								CHEMICAL						GEOLOGICAL AND GEOPHYSICAL						BIOLOGICAL AND FISHERY: POPULATION								BIOLOGICAL AND FISHERY: EXPERIMENTAL				METEOR				POLLUTION				ENGINEERING						OTHER					
AGENCY WHICH MAINTAINS DATA BASE	PRESSURE TEMPERATURE DENSITY	CURRENTS	TIDES	WAVES	SWELL, SURF	DRIFT MEASUREMENTS	FRESH WATER INFLOW/EXCHANGE	MIXING PARAMETERS	SALINITY	NUTRIENTS	BUFFER SYSTEM	DISSOLVED GASES	RADIOACTIVITY	ELEMENTS	ROCK OR SEDIMENT SAMPLES	ROCK OR SEDIMENT DESCRIPTIONS	SEDIMENTARY PROCESSES	DEPTH	BOTTOM PHOTOGRAPHS	GEOPHYSICAL MEASUREMENTS	SPECIMEN HOLDINGS	TAXONOMIC POSITION	OCCURRENCE & ABUNDANCE	PRIMARY PRODUCTIVITY	COLLECTION DATA	MIGRATION & MOVEMENTS	AGE, GROWTH, AND MORTALITY	FISHERY STATISTICS	COMPARATIVE PHYSIOLOGY	BEHAVIOR	POPULATION GENETICS	ENDOCRINOLOGY	AIR CHARACTERISTICS	WINDS	CLOUDS	HEAT BUDGET	CHEMICAL POLLUTANTS	HEAT & RADIOACTIVITY	MICROBIAL POLLUTANTS	OTHER SOLID WASTES	WAVE CHARACTERISTICS	WIND FORCES	CURRENT CONDITIONS	ENGINEERING PROPERTIES OF BOTTOM	SEDIMENT TRANSPORT & COASTAL EROSION	BEHAVIOR OF MATERIALS	ACOUSTICS	ELECTROMAGNETICS	OPTICS	SEA ICE	BIOMEDICINE	IMAGERY
NATIONAL OCEANOGRAPHIC DATA CENTER	X	X				X			X	X		X				X	X	X	X	X		X	X	X																							X					
U.S. ARMY COE (CERC)				X	X																																				X	X	X	X	X							
U.S. COAST GUARD	X	X		X	X	X			X	X		X						X	X														X	X	X											X				X	X	
U.S. GEOLOGIC SURVEY							X								X	X	X	X	X	X																																
U.S. NAVY:																																																				
NAVOCEANO	X	X	X	X	X	X	X	X	X	X			X		X	X	X	X	X	X	X		X			X								X				X			X		X	X			X		X	X		X
NURDC	X								X																																						X	X		X		
NWSC	X	X	X	X	X	X																											X	X	X	X											X			X		
U.S. LAKE SURVEY																																																				
GLRDC	X	X	X	X	X		X		X	X	X	X		X				X															X	X			X		X		X	X	X	X	X					X		
ESSA USWB			X	X	X																												X	X	X	X														X		X
COAST & GEODETIC SURVEY	X	X	X	X		X			X			X			X	X		X		X													X	X	X								X									
NESC																																			X	X														X		X
NMC	X			X	X																												X	X	X	X							X							X		
FDS (NWRC)	X			X	X																												X	X	X															X		X
ENVIRONMENTAL RESEARCH LAB	X	X	X	X		X			X	X	X				X	X	X	X	X	X				X									X	X	X	X																
WORLD DATA CENTER-A	X	X	X	X	X				X	X		X				X		X		X			X	X									X	X	X																	
FWPCA	X							X	X	X	X	X	X	X																							X	X	X	X												
SCRIPPS INSTITUTE	X	X	X			X			X	X		X			X	X	X	X	X	X	X	X	X	X		X	X		X	X	X	X																				
STATE OF CALIFORNIA:																																																				
WATER RESOURCES BOARD	X							X																													X	X	X	X												
FISH & GAME	X																						X			X	X	X																								
SOSC															X	X		X			X	X	X		X	X																										
BUREAU OF COMMERCIAL FISHERIES	X	X							X	X	X	X				X		X			X	X	X		X	X	X	X	X	X	X		X	X	X												X		X			X

TABLE III-2
DESCRIPTION OF DATA BASES

DATA BASE	CONTENTS	SOURCE	FORMAT	GEOGRAPHIC COVERAGE	PRODUCTS PRODUCED FROM DATA BASES	VOLUME	GROWTH	STORAGE MEDIA	ORGANIZATION
NATIONAL OCEANOGRAPHIC DATA CENTER DATA BASES DESCRIPTION									
BT DATA	[illegible]	[illegible]	DIGITAL [illegible]	[illegible]	INVENTORIES, [illegible]	[illegible] OBSER-VATIONS [illegible]	[illegible] OBSER-VATIONS [illegible]	CARDS & [illegible]	CRUISE & GEO-GRAPHIC
[illegible] STATION DATA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	CARDS & [illegible]	[illegible]
SURFACE CUR-RENT DATA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DRIFT & [illegible] DATA	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]		[illegible]			[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]				[illegible]		[illegible]	[illegible]	[illegible]
[illegible] (PLANNED)	[illegible]	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]
[illegible] (PLANNED)	[illegible]	[illegible]	[illegible]		[illegible]				[illegible]
[illegible] (PLANNED)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
SATELLITE OCEANOGRAPHIC DATA (PLANNED)	DATA MEASURED [illegible] BY SATELLITE & DATA [illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
SOUND VELOCIMETER DATA (PLANNED)	SOUND VELOCIMETER DATA	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	GEOGRAPHIC & [illegible]
UNDERWATER PHOTOGRAPHY DATA (PLANNED)	LOCATION, TIME, TYPE & PHYSICAL LOCATION OF UNDERWATER PHOTOGRAPH	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]

TABLE III-2 (Cont'd.)
DESCRIPTION OF DATA BASES

DATA BASE	CONTENTS	SOURCE	FORMAT	GEOGRAPHIC COVERAGE	PRODUCTS PRODUCED FROM DATA BASES	VOLUME	GROWTH	STORAGE MEDIA	ORGANIZATION
NAVAL OCEANOGRAPHIC OFFICE DATA BASES DESCRIPTION									
BATHYMETRIC LIBRARY (DOD LIBRARY)	SOUNDINGS	FIELD BRANCH SURVEYS	ANALOG TRACES; SHEETS, FINAL REPORT	DEEP OCEANS	CHARTS, MANUSCRIPTS, & DATA SHEETS	12M SOUNDINGS 300 SURVEYS	1M SOUNDINGS PER YEAR (APPROX. 25 SURVEYS PER YEAR)		90% IN NON-AUTOMATED FILES FILED BY SOURCE & BY AREA
		COASTAL SURVEYS	SHEETS, LOGS, ANALOG TRACES, FINAL REPORTS	COASTAL AREAS	SAME AS ABOVE	15M SOUNDINGS (3000 SURVEYS)	150K SOUNDINGS YEAR	SURVEY SHEETS (APPROX. 97% OF TOTAL); CARDS (APPROX. 3% OF TOTAL)	
		RANDOM TRACK DATA INCLUDING USN SHIP REPORTS	CHARTS, ANALOG TRACES, LETTERS, SOUNDING REPORT FORMS, LOG BOOKS	WORLDWIDE	SAME AS ABOVE	8.5M SOUNDINGS	375K SOUNDINGS PER YEAR	DIGITAL (1.2M)	
		SPECIAL STUDIES	DIGITAL	SPECIAL AREA AREAS	SAME AS ABOVE		1M SOUNDINGS IN 1967, 0.9M IN 1968	CARDS	
		OCEAN SURVEY PROGRAM	ANALOG TRACES MAGNETIC TAPE		SAME AS ABOVE	5.9M SOUNDINGS THROUGH MID 1967	1.4M SOUNDINGS PER YEAR	TAPE	
		[illegible] PROGRAM			SAME AS ABOVE		1M SOUNDINGS PER YEAR		
		FUTURE DATA COLLECTION PROGRAMS			SAME AS ABOVE		[illegible] SOUNDINGS PER YEAR		
GRAVITY LIBRARY	MEASURED & PROCESSED VALUES OF LOCAL GRAVITY OBSERVATIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] GRAVITY OBSERVATIONS PER YEAR, [illegible]	CARDS, TAPES, SHEETS, CHARTS, REPORTS	CARDS BY GEOGRAPHICAL AREA; TAPES BY SURVEY ACCESSION NUMBER
GEOMAGNETIC LIBRARY	MAGNETIC DATA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] PER YEAR [illegible]	[illegible]	[illegible] & AREA
		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	SAME AS ABOVE	
		[illegible]		[illegible]		[illegible]	[illegible]		
		MAGNETIC VARIATION ANOMALY DATA		[illegible]		[illegible]		[illegible]	
		OCEAN SURVEY PROGRAM	[illegible]			[illegible]	[illegible]	[illegible]	
		MARINE [illegible] PROGRAM	[illegible] & IMAGES ON MAGNETIC [illegible]	[illegible]					
		[illegible]	REPORTS, [illegible]						
		NON-DOD SOURCES, C&GS, USGS, NSF, FOREIGN INSTITUTIONS & COMPANIES	[illegible]	[illegible]					
DAILY ICE OBSERVATIONS	TABULATIONS OF SEA-ICE & ICEBERGS (INCLUDES DATA, TYPE OF ICE & REMARKS)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	GEOGRAPHIC [illegible]
PORT ICE CONDITIONS	OBSERVATIONS OF SEA-ICE	PUBLISHED & UNPUBLISHED SOURCES (INCLUDING CLASSIFIED DATA)		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
SATELLITE ICE OBSERVATIONS	7 DAY ICE LIMITS & CONCENTRATION	SATELLITE PHOTOGRAPHIC (ESSA III & V)		ARCTIC, ANTARCTIC, NORTH ATLANTIC, NORTH PACIFIC, BLACK SEA, SEA OF AZOR[illegible]	ICE ATLASES	[illegible]		BASE CHARTS [illegible]	
SEA SURFACE OBSERVATION FILE	SEA SURFACE - TEMPERATURE, SALINITY, SIGMA-T, LOCATION & DATE	SCIENTIFIC REPORTS (SHIP OBSERVATIONS NOT INCLUDED)		WORLDWIDE	[illegible]	[illegible]	[illegible]	[illegible]	MARSDEN SQUARE & [illegible] QUADRANGLE

TABLE III-2 (Cont'd.)
DESCRIPTION OF DATA BASES

DATA BASE	CONTENTS	SOURCE	FORMAT	GEOGRAPHIC COVERAGE	PRODUCTS PRODUCED FROM DATA BASES	VOLUME	GROWTH	STORAGE MEDIA	ORGANIZATION
NAVAL OCEANOGRAPHIC OFFICE DATA BASES DESCRIPTION									
SUBSURFACE CURRENT PROFILES	CURRENT VELOCITY, DEPTH, WIND DIRECTION, BOTTOM [illegible], DATE, OBSERVATION TECHNIQUE				CURRENT ATLASES	3,000 PROFILES		TABULATION SHEETS, PROFILES, & CARDS	
SUBMARINE SEDIMENT DATA FILE	RESULTS OF ANALYSIS OF SEDIMENT SAMPLES & PHOTOGRAPHS	SCIENTIFIC REPORTS	NAVAL OCEANOGRAPHIC OFFICE FORMAT	WORLDWIDE	BOTTOM CHARACTERISTICS MAPS	38,346 SAMPLES	4,000 PER YEAR	PUNCHED CARDS	MARSDEN SQUARE
ENVIRONMENTAL DATA SERVICE (NATIONAL WEATHER RECORDS CENTER) DATA BASES DESCRIPTION									
MARINE SURFACE OBSERVATION FILE	SURFACE OBSERVATION DATA	OCEAN STATION VESSELS, USN, USCG, USC&GS, MERCHANT VESSELS, COASTAL STATIONS, FISHING BOATS, BUOYS, ISLANDS	STANDARD WMO FORMAT	WORLDWIDE	MARINE CLIMATOLOGICAL ATLASES, REQUESTED PRODUCTS	33,431,000 OBSERVATION RECORDS	528,000 U.S., 828,000 PURCHASED, 154,000 INTERNATIONAL EXCHANGE	CARDS, TAPES, & MICROFILM	SOURCE, LOCATION, DATE & TIME
WBAN ROABS CONSTANT PRESSURE	UPPER AIR OBSERVATION DATA [illegible] LEVELS	OCEAN STATION VESSEL, USN, USCG, USC&GS, MSTS SHIPS, FOREIGN COOPERATIVES, MERCHANT SHIPS	STANDARD WMO FORMAT	WORLDWIDE	MARINE CLIMATOLOGICAL ATLASES & REQUESTED PRODUCTS	1,000,000 OBSERVATIONS	6,000 CARDS PER YEAR/ STATION	PUNCHED CARDS, MAGNETIC TAPE, & CARD IMAGES ON MICROFILM	STATION (OR VESSEL NUMBER))
ROAB SIGNIFICANT LEVELS	OBSERVATION DATA AT SIGNIFICANT LEVELS	SAME AS ABOVE	STANDARD WMO FORMAT	WORLDWIDE	MARINE CLIMATOLOGICAL ATLASES & REQUESTED PRODUCTS	1,000,000 (APPROXIMATE) OBSERVATIONS	12,000 CARDS PER YEAR/ STATION	PUNCHED CARDS, CARD IMAGES ON MICROFILM	STATION (OR VESSEL NUMBER))
NATIONAL METEOROLOGICAL CENTER DATA BASES DESCRIPTION									
COLLECTIONS OF SURFACE AND UPPER AIR METEOROLOGICAL OBSERVATIONS SERVE AS BASE FOR 6-LAYER PE MODEL	RELATIVE HUMIDITY, PRECIPITATION, PRESSURE, AIR TEMPERATURE, WIND VELOCITY, VORTICITY, HEIGHTS, VERTICAL VELOCITY FOR SURFACE TO 100 MB	NMC	COMPUTED ELEMENTS STORED IN 399 (60 BIT) WORD RECORDS	NORTHERN HEMISPHERE ABOVE 10° NORTH LATITUDE	HEMISPHERIC WEATHER CHARTS, EXTENDED RANGE WEATHER FORECASTS, WAVE HEIGHTS FORECASTS	5 YEARS OF DATA, NOT TOTALLY COMPLETE	720 PER YEAR 2 TAPES DAILY	TAPE	COMPUTED VALUES BY GRID POINT
SEA SURFACE TEMPERATURE MEANS	A 10-DAY & MONTHLY MEAN VALUE ON A 5° LATITUDE LONGITUDE GRID	NMC, JAPAN METEOROLOGICAL AGENCY	2 VALUES FOR EACH GRID POINT	NORTH ATLANTIC & NORTH PACIFIC OCEANS	EXTENDED RANGE FORECASTS	[illegible] YEARS OF DATA	1 ENTRY PER GRID POINT EVERY 10 DAYS	CARDS	BY GRID INTERSECTION & BY DATE
NATIONAL ENVIRONMENTAL SATELLITE CENTER (NESC) DATA BASES DESCRIPTION									
SNOW COVER	"YES-NO" INDICATOR FOR EACH POINT IN NWP GRID SYSTEM, DATE	ESSA SATELLITES, USCG REPORTS, USN, STATION REPORTS	1 INDICATOR FOR EACH GRID POINT	NORTHERN HEMISPHERE ABOVE 10° NORTH LATITUDE	HEMISPHERIC WEATHER CHARTS, WEATHER FORECAST, DOMESTIC & SEA ICE FORECASTS, ICE ATLASES		52 PER YEAR	MAGNETIC TAPE (NMC) 1:50,000,000 MERCATOR POLAR MAPS FOR NESC	1 ENTRY FOR GRID POINT STARTING WITH 0001 to 1977
SEA SURFACE TEMPERATURE ANALYSES	1 TEMPERATURE VALUE FOR EACH OCEAN GRID POINT, TIME & DATE	HAND DRAWN FROM ESSA SATELLITES, USCG, USN-FNWC	A VALUE FOR EACH GRID POINT	NORTHERN HEMISPHERE OCEAN AREAS ABOVE 10° NORTH LATITUDE	HEMISPHERIC WEATHER CHARTS, WEATHER FORECAST, SEA SURFACE TEMPERATURE CHARTS, DOMESTIC & SEA ICE FORECASTS				
MESO-SCALE AVCS AVERAGE BRIGHTNESS PRODUCTS	SATELLITE IDENTIFICATION NUMBER OF DAYS INCLUDED AVERAGE VALUE, BEGINNING & ENDING DATES	ESSA SATELLITE	EACH MULTI-DAY AVERAGE FOR ALL GRID POINTS CONSTITUTES ONE TAPE FILE	GLOBAL	AVERAGE BRIGHTNESS CHARTS: 5-10 DAY, MONTHLY, SEASONAL	5? (APPROXIMATE) MAGNETIC TAPES	DATA FOR 6 MONTHS MAINTAINED, OTHER TAPES RECIRCULATED	MAGNETIC TAPE & 35MM FILM	SATELLITE ID, PRODUCT, AND DAY
POLAR & MERCATOR MAPPED PHOTOS	[illegible] & VIDEO DATA, CLOUD COVER, ORBITAL ELEMENTS, TAPE NUMBER, CAMERA NUMBER, NUMBER OF PICTURES & SATELLITE ID	[illegible] SATELLITES	35MM FILM NEGATIVES & TAPE	GLOBAL	SATELLITE BRIGHTNESS CHARTS, [illegible] ATLASES, SATELLITE PHOTOS, [illegible] CLOUD CLIMATOGRAPHY PUBLICATIONS	[illegible] (APPROXIMATE) ROLLS OF 35MM FILM, [illegible] (APPROXIMATE) MAGNETIC TAPES	[illegible] ROLLS OF FILM ANNUALLY, MAGNETIC TAPE [illegible] CONSTANT	TAPE & 35MM FILM	SATELLITE ID, & ORBIT (DATE & TIME)
FLEET NUMERICAL WEATHER CENTRAL DATA BASE DESCRIPTION									
SYNOPTIC REPORTS OF OCEAN CONDITIONS &	AWN AIR FORCE WEATHER DATA	NETWORK	ALL DATA REFORMATTED TO SIXBIT FORMAT	NORTHERN HEMISPHERE	[illegible] TYPES OF ANALYSES & PREDICTIONS FOR THE OCEANS	[illegible] SHIP REPORTS OF SEA SURFACE TEMPERATURE PER [illegible] DAYS	[illegible] FIELDS PER DAY	TAPE	
	NEDN NAVY ENVIRONMENTAL DATA INCLUDING SEA TEMPERATURES TO [illegible] DEPTH	DATA NET	STACKED BINARY BCD			[illegible] XBT'S ON FILE	[illegible] XBT REPORTS PER DAY		
	AUTODIN UNCLASSIFIED & CLASSIFIED NAVY DATA	DIGITAL NET	ANALOG [illegible]			[illegible] UPPER AIR OBSERVATIONS PER DAY			
	APES AIRWAY WEATHER DATA (ESSA)	INTERCHANGE SYSTEM							
HISTORICAL WEATHER MAPS	SURFACE PRESSURE PATTERN & 500 MB HEIGHT PATTERN	HISTORICAL MAP SERIES	COMPUTER GRID	NORTHERN HEMISPHERE	SPECIAL [illegible]	[illegible] DAILY AT BOTH LEVELS FOR [illegible] YEARS	2 PER DAY	TAPE	
NANSEN CAST DATA	SEA TEMPERATURE & SALINITY AT SELECTED DEPTHS	NODC, USSR ATLAS, & METEOROLOGICAL ATLASES	OCEAN STATION	NORTHERN HEMISPHERE	[illegible] SPECIAL PROJECTS	[illegible] STATIONS		11 TAPES (BINARY)	SORTING BY 1° AREAS & BY MONTH

TABLE III-2 (Cont'd.)
DESCRIPTION OF DATA BASES

DATA BASE	CONTENTS	SOURCE	FORMAT	GEOGRAPHIC COVERAGE	PRODUCTS PRODUCED FROM DATA BASES	VOLUME	GROWTH	STORAGE MEDIA	ORGANIZATION
SMITHSONIAN OCEANOGRAPHIC SORTING CENTER DATA BASES DESCRIPTION									
SMITHSONIAN INSTITUTION INFORMATION RETRIEVAL SYSTEM	TAXONOMIC DIRECTORY ITEMS & AUXILIARY DATA BASE ITEMS	NATURAL HISTORY MUSEUM OF CANADA, BRITISH MUSEUM OF NATURAL HISTORY, U.S. MUSEUMS, BCF, USGS, NIH, ONR, FWPCA, C&GS, USCG, NSF, USN, & AEC	FIXED AND VARIABLE LENGTH RECORDS	GLOBAL	DESCRIPTIVE LISTS	[illegible],000,000 SPECIMENS (MOST OF WHICH ARE NOT IN DIGITIZED FORM)		TAPE & DISC	BINOMIAL & LOCATION
COAST AND GEODETIC SURVEY DATA BASES DESCRIPTION									
HYDROGRAPHIC & WIRE DRAG SURVEY SHEETS	SOUNDINGS, FIELD LOCATED INFORMATION & WIRE DRAGGED AREAS	C&GS SURVEY VESSELS	STANDARD C&GS HYDROGRAPHIC MANUAL FORMAT	U.S. CONTINENTAL SHELF, U.S. POSSESSIONS	NAUTICAL CHARTS, BATHYMETRIC MAPS	8,500 SHEETS	60 SHEETS PER YEAR	HARD COPY, CARDS, & LISTINGS	HISTORICAL (REGISTRY NUMBER)
TIDE HEIGHTS	TIDE HEIGHT & TIME, AT PERMANENT & TEMPRRARY TIDE GAUGE STATIONS	C&GS, LATIN AMERICAN COUNTRIES, NAVY		WESTERN HEMISPHERE	TIDE TABLES, [illegible] SUMMARIES, & TIDE DATA	8,500 OBSERVATION STATION-YEARS (ESTIMATED)	100 OBSERVATION STATION YEARS (STRIP-CHART), 50 OBSERVATION STATION YEARS (DIGITAL)	STRIP CHARTS, CARDS, & LISTINGS	
AIDS TO NAVIGATION	AIDS TO NAVIGATION CHANGES & SOURCES NOTED ON CHART (AID PROOF)	C&GS, COAST GUARD, NAVY		U.S. CONTINENTAL SHELF, U.S. POSSESSIONS	NAUTICAL CHARTS	1 AID PROOF FOR EACH CHART ON ISSUE	16,000 CORRECTIONS (400 AID PROOFS REPLACED PER YEAR)	AIDS PROOFS (MICROFILM PRIOR TO 19[illegible])	CHART NUMBER
OBSTRUCTIONS FILE	LOCATION, TYPE OF OBSTRUCTION AND SOURCES NOTED ON CHART (AID PROOF)	C&GS, COAST GUARD, NAVY, COE, STATE & LOCAL AGENCIES, PRIVATE BOATERS, MERCHANT SHIPPING		SAME AS ABOVE	SAME AS ABOVE	85[illegible] CHARTS		CHARTS	CHART NUMBER
CHART LETTERS	CHANGE & SOURCE NOTE PUT ON CHART STANDARD	SAME AS ABOVE		SAME AS ABOVE	SAME AS ABOVE	500 CHART STANDARDS	[illegible] STANDARD, 2,000 LETTERS PER YEAR	LETTERS - HARD COPY (MICROFILM PRIOR TO 19[illegible])	CHART LETTERS - CONSECUTIVE NUMBERS, YEAR CHART STANDARDS - CHART NUMBER
BLUEPRINTS	SAME AS ABOVE	SAME AS ABOVE		SAME AS ABOVE	SAME AS ABOVE	[illegible] BLUEPRINTS	2,[illegible] PER YEAR	HARD COPY	CHART NUMBER
BATHYMETRIC DATA BANK	[illegible] OF SURVEY DATA	C&GS SURVEY [illegible]	RECORDS, [illegible]	SAME AS ABOVE	BATHYMETRIC [illegible], NAUTICAL CHARTS, [illegible]			HARD COPY, CARDS	CHART NUMBER, [illegible]
COAST PILOT REPORTS	COAST PILOT INFORMATION	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
AERIAL PHOTOGRAPHS	COASTAL FEATURES	[illegible]	[illegible]	SAME AS ABOVE	[illegible]			[illegible]	[illegible]
CURRENT INFORMATION	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TEMPERATURE & DENSITY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]									
DETECTED TSUNAMIS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]									
[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]	[illegible]				[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]
[illegible]	CURRENT [illegible]	[illegible]		[illegible]				[illegible]	

TABLE III-2 (Cont'd.)
DESCRIPTION OF DATA BASES

DATA BASE	CONTENTS	SOURCE	FORMAT	GEOGRAPHIC COVERAGE	PRODUCTS PRODUCED FROM DATA BASES	VOLUME	GROWTH	STORAGE MEDIA	ORGANIZATION
GREAT LAKES REGIONAL DATA CENTER DATA BASES DESCRIPTION									
WATER CHARACTERISTICS (PLANNED)	PHYSICAL, CHEMICAL, & BIOLOGICAL MEASUREMENTS & SAMPLE DATA	LAKE SURVEY		GREAT LAKES	WATER CHARACTERISTICS ATLAS PLANNED	1000 STATIONS (ESTIMATED) (200 LOCATIONS)	350 STATIONS (70 LOCATIONS)	CARDS	STATION
WATER TEMPERATURE	SURFACE WATER TEMPERATURE, TIME, OBSERVATION STATION (DIGITIZED ON HOURLY BASIS)	10 GAUGES OPERATED BY LAKE SURVEY, 14 GAUGES OPERATED BY STATE, LOCAL & PRIVATE		GREAT LAKES	WATER TEMPERATURE SUMMARIES	550 OBSERVATION STATION YEARS (ESTIMATED)	24 OBSERVATION STATION YEARS	CARDS	STATION, DAILY, MONTHLY
WATER QUANTITY (DISCHARGE)	FLOW RATE, TIME, OBSERVATION STATION	LAKE SURVEY FIELD PARTIES		[illegible] LAKES		[illegible] SECTIONS	5-15 SECTIONS	CARDS	SECTION (OF STREAM OR LAKE)
WATER QUANTITY (PRECIPITATION)	PRECIPITATION, AMOUNT, TIME, EVAPORATION RATE, OBSERVATION STATION	WEATHER BUREAU & LAKE SURVEY, 10 GAUGES PRECIPITATION SELECTED WB STATIONS, 6 GAUGES EVAPORATION		GREAT LAKES		[illegible] STATION-MONTHS (PRECIPITATION & EVAPORATION)	16 OBSERVATION STATION-YEARS	PUNCHED CARDS	STATION
ICE OBSERVATION (ICE THICKNESS, DISTRIBUTION & TYPE) (PLANNED)		LAKE SURVEY LAKE LEVEL OBSERVERS, CANADIANS, COAST GUARD, WEATHER BUREAU, 10 FLIGHTS YEAR (CG PLANE)		GREAT LAKES	ICE SUMMARIES	[illegible],000 ICE DISTRIBUTION & TYPE OBSERVATIONS, 5,000 ICE THICKNESS OBSERVATIONS, 150 CG OBSERVATION STATION YEARS	7,000 ICE DISTRIBUTION & TYPE OBSERVATIONS PER YEAR, 1,000 ICE THICKNESS OBSERVATIONS PER YEAR, 20 COAST GUARD OBSERVATION STATIONS PER YEAR	HARD COPY	STATION
U.S. LAKE SURVEY DATA BASES DESCRIPTION									
FIELD SHEET	SOUNDINGS, FIELD LOCATED INFORMATION & LAKE LEVELS	U.S. LAKE SURVEY FIELD PARTIES	FIELD SHEET FORMAT	GREAT LAKES REGION	FIELD SHEET COPIES	2,[illegible]	15-25 FIELD SHEETS	ORIGINAL SHEETS (HARD COPY)	SERIAL NUMBER (HISTORICAL ORDER)
OFFICE COPY (CHART STANDARD)	CHART CHANGES & [illegible] NOTES	[illegible]	SAME AS [illegible]	GREAT LAKES REGION	NAVIGATION [illegible] NAUTICAL CHARTS [illegible]	[illegible]	[illegible] CHARTS PER YEAR [illegible]	[illegible] COPY	CHART NUMBER
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]									
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]									
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE III-2 (Cont'd.)
DESCRIPTION OF DATA BASES

DATA BASE	CONTENTS	SOURCE	FORMAT	GEOGRAPHIC COVERAGE	PRODUCTS PRODUCED FROM DATA BASES	VOLUME	GROWTH	STORAGE MEDIA	ORGANIZATION
U.S. GEOLOGICAL SURVEY DATA BASES DESCRIPTION									
TOPOGRAPHIC DIVISION FILES	FIELD SHEETS, GEODETIC CONTROLLED AIR OS, AIR AIR PHOTO MOSAICS	USGS	VARIES	ALL U.S. & TERRITORIES, POSSESSIONS & SELECTED FOREIGN AREAS	ALL SERIES OF TOPOGRAPHIC MAPS PUBLISHED BY USGS	CONTROL & PHOTOS ARE FILED ON REGIONAL BASIS (4 REGIONAL OFFICES); SCRIBE COAT MASTERS ARE FILED IN WASHINGTON. CONTROL DATA & AIR PHOTOS ARE FILED AS STANDARD HARD COPY			
FILES ON OUTER CONTINENTAL SHELF LANDS	STATISTICAL DATA ON LEASING OF FEDERAL LANDS FOR OIL & MINING ACTIVITIES, & TECHNICAL MANAGEMENT OF THESE LANDS	BUREAU MANAGEMENT, INTERNAL FILES, OIL COMPANIES	VARIES	OUTER CONTINENTAL SHELF LANDS	NO FORMAL DATA PRODUCTS OTHER THAN BILLING TO OIL COMPANIES FOR ROYALTY & INTERNAL REPORTS	ABOUT 25% OF WORK APPLIES TO FEDERALLY OWNED OFFSHORE LANDS. FILES ARE COMPUTERIZED FOR ROYALTY ACCOUNTING			
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION DATA BASES DESCRIPTION									
STORAGE & RETRIEVAL (STORET)	HYDROLOGICAL, METEOROLOGICAL, PHYSICAL, CHEMICAL, BIOLOGICAL, STATION IDENTIFICATION, & IMPLEMENTATION SCHEDULES	USGS, FWPCA, STATE AGENCIES		U.S. CONTINENTAL, ALASKA, HAWAII, U.S. COASTAL	COMPARISONS OF FACILITIES VERSUS CONSTRUCTION SCHEDULES, MONITORING REPORTS	18,000 STATIONS		TAPE, DISC	BY STATION NUMBER & BY DATE
NAVAL UNDERSEA RESEARCH AND DEVELOPMENT CENTER DATA BASES DESCRIPTION									
OCEANOMETRICS SECTION	NANSEN CAST DATA, BT DATA, ANALYSES OF ABOVE DATA	NODC, NURDC SURVEYS	PRINTOUTS, LISTINGS, PRINTS & PLOTS	ALL DATA WITHIN 100 NMI RADIUS OF SELECTED POINTS	TECHNICAL REPORTS, ACOUSTIC PREDICTIONS	SMALL (1-2 CABINETS)	4 SETS OF DATA PER YEAR (APPROXIMATE)	FOLDERS	NUMERICALLY BY MASTER INDEX
OCEANOGRAPHIC SECTION	ALL AVAILABLE OCEANOGRAPHIC DATA WORKING TAPES HAVE DENSITY, TEMPERATURE, SALINITY SOUND, VELOCITY, SIGMA T, SPECIFIC VOLUME ANOMALY	NODC, FNWC, GREAT BRITAIN, NIO, & MARINE GEOPHYSICAL SURVEY	TAPES, CARDS, MICROFILM, & LOGS	GLOBAL	SUPPORT INFORMATION & ENVIRONMENTAL SUMMARIES OF SPECIFIC AREAS	360,000 OCEAN STATIONS, 105,000 OCEAN STATIONS, 40,000 CARDS OF [illegible] DATA	SAME RATE AS NODC BUILDS UP TAPE LIBRARY; SEMI-ANNUAL INPUTS FROM FNWC	TAPES, PRINTED CARDS, & MICROFILMS	
NAVY EXPERIMENTAL DIVING UNIT [illegible] DATA BASE [illegible]									
DIVING ACCIDENT REPORTS	ALL U.S. NAVY DIVING ACCIDENTS & REPORTS ON ALL ACCIDENT CASES TREATED ON U.S. NAVY FACILITIES	ALL U.S. NAVY [illegible]	CARDS, FILE & [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	RECORDS OF ALL U.S. NAVY DIVERS	ALL U.S. NAVY DIVING UNITS & FACILITIES	CARDS, [illegible]	[illegible]	[illegible]			[illegible]	[illegible]
[illegible]									
[illegible]	[illegible] DATA, [illegible] DATA	OCEAN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] MEASUREMENTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	PLANKTON SAMPLES, [illegible] DATA, [illegible], ENVIRONMENTAL DATA, & [illegible] SHEETS	[illegible], INTERAMERICAN [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	FISH SPECIMENS, FIELD DATA [illegible], [illegible] RECORDS, ENVIRONMENTAL DATA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] BY [illegible]

content, source of the data, use of the data in preparation of products, and 1968 volume and growth information. The information describing the current volume of holdings for each data base provides a partial index of the past volume of data collection, and, therefore, of past requirements for the particular category of data included in the data base. However, this information is of limited value since a significant part of the data collected has not been entered in data bases, and since there are extensive delays in processing certain types of data. Unfulfilled past data requirements are also not reflected in this information.

A more meaningful index of baseline requirements for the various categories of data is the current growth rate information contained in the table. For those types of data for which a formal input schedule exists, and for which essentially complete data are acquired for filing, the current growth rate information provides an accurate estimate of the current rate of data collection. If the current needs for these data are being fulfilled within the existing data handling constraints of the particular service, the current growth rate provides a direct estimate of the current requirement for these data. Even in this case, of course, the estimate is a minimum baseline, since the need for an increased volume of data collection grows continually for most data types.

PROJECTED DATA REQUIREMENTS

Current and future requirements for marine data collection are determined by (1) user demand, (2) platform availability, (3) instrumentation state of the art, and (4) the capacity of the various data services to acquire and process data and disseminate data and data products. The end use of most marine data is the preparation of a product; therefore, the requirement for data results principally from the demand for products. Estimates of the projected annual volumes of the major existing data products are included in the following sections of this chapter. Each of these products requires a minimum set of input data. The principal component of the projected increase in volume of

data collection can be directly estimated from the increase in product volume. For most data types, the volume requirements of researchers, resource managers and planners, and other direct data users are negligible. Only for specialized types of data is it necessary to supplement the projected volumes based on these non-product requirements.

The demand for data from the product producers and from other direct data users provides the positive impetus for a growth in the total volume of data collection. The limiting factors are the availability of data collection platforms, data collection instrumentation technology, and the capacities of the various data services to assimilate increased data volumes in their operations. Data collection platforms include survey vessels, ships of opportunity, Naval vessels, coastal and island stations, aircraft, satellites, buoys, fixed platforms, etc. In recent years, the total number of available platforms has increased, as have the kinds of platforms (e.g., satellites); and current plans exist to significantly augment this number (e.g., data buoys). With the increasing development of marine activities, the number of available platforms will continue to increase. Cost/benefit considerations will determine the rate of this increase.

The second limiting factor to the growth of data volume is the state of the art of instrument technology. The collection of some types of data required manned observations (or human analysis of samples). The effectiveness of the planned data buoy system is also presently limited by the lack of reliable instruments. Extensive activity exists in a number of laboratories to develop reliable techniques and instruments for automated data collection. Most of the possible types of satellite observations are still in the developmental stage. The successful development of operational automated systems will result in a major increase in data volume.

The third limiting factor is the capacity of the data service. An increase in the rate of data collection will result in an increased demand on the available transmission networks, as well as the processing, storage, analysis, dissemination activities. Overall improvements in data handling efficiency will be required.

Projections of volumes for selected data parameter groups are indicated in Table III-3. The projections are intended to be illustrative of the rate of growth of diverse data types. A number of parameter groups are not included. The current annual volumes in the table are based on 1968 data from available sources (see Table III-2). The growth rates are based on ship-year requirements for the program recommended by the task group for the Ten Year Plan for Ocean Exploration, projections for NAVOCEANO data collection programs, ESSA projections for meteorological data, and the results of the user demand analysis discussed in Chapter VI.

The data parameter groups included in the table are temperature (sea surface and bathythermal), currents, tides, swells, dissolved oxygen, bathymetric soundings, magnetic measurements, gravity measurements, marine surface weather observations (ship, island, coastal, and buoy), cores, bottom samples, and plankton tows. With the exception of plankton tows, the data have been converted into the annual volumes of characters, thus providing a means of comparison for divergent parameter groups. The analog data (including strip chart recordings, meter hours, and gauge hours) have been converted to digital data by assuming a given number of data points per nautical mile, hour, or depth distance. These conversions can be derived from the current volume figures which are expressed in both natural units and characters (e.g., three characters per SST observation, 100 characters per Nansen cast, 80 characters per BT chart, etc.).

For most of the parameter groups, the growth rate expected during the 1971-80 period has been assumed to be constant. New developments in platform, instruments, and overall effort will, in fact, result in a more irregular growth rate;

TABLE III-3
CURRENT AND PROJECTED REQUIREMENTS FOR SELECTED DATA PARAMETER GROUPS

PARAMETER GROUP	DATA COLLECTORS	CURRENT ANNUAL VOLUMES(1) NATURAL UNITS	CURRENT ANNUAL VOLUMES(1) CHARACTERS (X10^6)	FY 71	FY 72	FY [illegible]	FY [illegible]	FY [illegible]	FY [illegible]	FY [illegible]	FY [illegible]	FY [illegible]	FY [illegible]	TOTAL
TEMPERATURE	CAGS, [illegible], BCF, INSTITUTIONS, NAVY, [illegible], EDS	[illegible] OBSERVATIONS	[illegible]	4.96	5.25	5.58	[illegible]	[illegible]	[illegible]	[illegible]	6.61	6.94	[illegible]	[illegible]
		[illegible] NAUTICAL MILES, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible] BT CHARTS	[illegible]	22.96	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible] STD RECORDINGS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CURRENTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TIDES ASTRONOMICAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SALINITY	NAVY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]													[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DATA COLLECTORS: [illegible]

however, it is not possible at the present time to determine the year in which new data collection programs, such as the data buoy system will become operational. The total FY 80 volume (10.6×10^9 characters) is three times the total FY 71 volume (3.45×10^9 characters) for these selected data parameters.

FORECASTING DATA PRODUCTS REQUIREMENTS

CURRENT PRODUCTION

Forecasting data products are characterized by the limited time periods in which they are valid. These periods [illegible] determined by the particular forecast product. For example, since atmospheric conditions change more rapidly than oceanographic conditions, the useful period of a weather forecast is less than that of oceanic thermal structure forecasts. Nevertheless, the validity of all these forecasts degrades rapidly wit time. It is necessary to issue frequent forecasts, based on new synoptic analyses, on a regularly scheduled basis. The volume of these products is therefore large in comparison to that of descriptive data products.

Weather and oceanographic forecasts are prepared and disseminated daily on a scheduled basis. Satellite products are obtained throughout the year, on a schedule determined by the orbital periods. Warnings and advisories are prepared and issued only when hazardous conditions are expected; therefore, the volume of these products is limited. Ice forecasts are issued only during a part of the year, as are fishing advisories.

Some of the major forecasting products are described in table III-4. The table includes a description of each product, the data bases used to prepare the product, and the volume of the product for those data service organizations contacted during the Part II study. For the regularly scheduled products the volume figures provide an accurate measure of the current annual (1968) volume.

TABLE III-4

ENVIRONMENTAL FORECASTING DATA PRODUCTS DESCRIPTION AND CHARACTERISTICS

DATA PRODUCT	CONTENTS	FORMAT	GEOGRAPHIC COVERAGE	DATA BASE USED TO PRODUCE PRODUCT	DATA USED IN PRODUCT	VOLUME PER TRANSMISSION TO CUSTOMER	FREQUENCY OF TRANSMISSION TO CUSTOMER	ANNUAL VOLUME DISTRIBUTED TO CUSTOMER
WEATHER BUREAU NATIONAL METEOROLOGICAL CENTER								
WAVE HEIGHT FORECASTS	WIND-WAVE SWELL, & COMBINED WAVE CHARTS	PLOTS ARE HEMISPHERIC, POLAR STEREOGRAPHIC PROJECTIONS	NORTH ATLANTIC, NORTH PACIFIC, GULF OF MEXICO, GULF OF ALASKA	PRIMITIVE EQUATION WIND FORECAST, WIND-WAVE, & HISTORY TAPES; POLAR ICE	ONLY DATA BASE DATA USED	24 CHARTS/DAY	8,760/YEAR	TWICE DAILY FOR EACH CHART
HEMISPHERIC WEATHER CHARTS (ANALYSES AND PROGNOSES)	SURFACE, UPPER AIR, & AUXILIARY ANALYSES; SURFACE & UPPER AIR PROGNOSES; EXTENDED FORECASTS; NEPHANALYSES	POLAR STEREOGRAPHIC PROJECTIONS OF NORTHERN HEMISPHERE	NORTHERN HEMISPHERE NORTH OF 10° NORTH LATITUDE	PRIMITIVE EQUATION MERGED OUTPUT, SNOW COVER, SEA SURFACE TEMPERATURE ANALYSES	SURFACE & UPPER AIR OBSERVATIONS AVAILABLE AT TIME OF PREPARATION	[illegible] FACSIMILE TRANSMISSIONS DAILY	[illegible] FACSIMILE	FOUR TIMES DAILY AS A GENERAL RULE
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION - WEATHER BUREAU								
EXTENDED RANGE WEATHER FORECASTS	TEMPERATURE, CLOUD COVER, & PRECIPITATION PREDICTIONS & SNOWCOVER	POLAR STEREOGRAPHIC PROJECTIONS OF NORTHERN HEMISPHERE	WORLDWIDE	PRIMITIVE EQUATION MERGED OUTPUT, SNOW COVER, SEA SURFACE TEMPERATURE ANALYSES, THERMAL PROFILE, OR OCEAN CLOUD COVER ALBEDO DATA	HORIZONTAL TURBULENT TRANSFER IN TROPOSPHERE, EXCESS OR RADIATION IN TROPOSPHERE & AT SURFACE OF EARTH, HEAT GAINS & LOSSES CLOUD COVER, ALBEDO			TWICE WEEKLY FOR TWO-WEEK FORECASTS (PLANNED)
COASTAL WEATHER FORECASTS	FORECASTS & WARNINGS; PRESSURE SYSTEMS, WIND VELOCITIES, AIR TEMPERATURES, SEA TEMPERATURES, & COASTAL WAVE CONDITIONS	NARRATIVE REPORTS NOT IN FIXED FORMAT, INDICATING WEATHER AT PARTICULAR AREAS & GENERAL TRENDS	COASTAL U.S. AREAS SEAWARD 50 MILES. ALSO INCLUDED ARE PUERTO RICO, ALASKA, AND HAWAIIAN COASTAL AREAS	NONE	SHIP COASTAL WEATHER REPORTS, HEMISPHERIC WEATHER CHARTS & WAVE FORECASTS (NMC), SATELLITE PHOTOS, & CLIMATOLOGICAL ATLASES	FOR VHF-FM TRANSMISSIONS, 5-7 MINUTES; FOR OTHER BROADCASTS, FORECASTS LIMITED TO LESS THAN OR EQUAL TO 350 WORDS	VHF-FM BROADCASTS CONTINUOUS, UPDATED EVERY THREE HOURS. OTHER FORECASTS ARE PRODUCED FOUR TIMES DAILY	18 VHF-FM STATIONS, SIX FORECASTS DAILY, 36,090 ANNUALLY. 18 AREA CENTERS, 4 FORECASTS DAILY•72, 26,280 ANNUALLY
HIGH SEAS WEATHER FORECASTS	ALPHANUMERIC DESCRIPTION OF FORECAST WEATHER CONDITIONS AND WARNINGS	EACH FORECAST IS LIMITED TO 350 WORDS, - NO FIXED FORMAT	NORTH PACIFIC: SAN FRANCISCO AREA FORECAST CENTER & HONOLULU AREA FORECAST CENTER. NORTH ATLANTIC & GULF OF MEXICO: WASHINGTON, D.C. AREA FORECAST CENTER	NONE	SHIP, ISLAND & AIRCRAFT WEATHER REPORTS, NMC HEMISPHERIC WEATHER CHARTS & WAVE FORECASTS, SATELLITE PHOTOS & CLIMATOLOGICAL ATLASES	LESS THAN OR EQUAL TO 350 WORDS PER FORECAST	FOUR FORECASTS DAILY FROM EACH CENTER = 12 PER DAY	4,380 PER YEAR
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION - NATIONAL HURRICANE CENTER								
TROPICAL CYCLONE ADVISORIES	LOCATION, MOVEMENTS, WIND SPEEDS, 12 & 24 HOUR FORECAST WARNINGS OF STORM SOURCE AND PRECIPITATION	BULLETINS IN SET FORMAT	CENTRAL & EASTERN PACIFIC, NORTH ATLANTIC, GULF OF MEXICO, CARIBBEAN	CLIMATOLOGICAL DATA	SURFACE DATA FROM SHIPS, SEA SURFACE TEMPERATURE FROM AIRPLANE IR SENSORS, SATELLITE PHOTOS, UPPER AIR REPORTS, HEAT FLUX AT AIR-SEA INTERFACE, AIRCRAFT OBSERVATIONS, RADAR DATA	VARIES	FOUR TIMES DAILY WHEN NECESSARY, WITH PUBLIC BULLETINS EVERY 2 or 3 HOURS	600 (AVERAGE OF 44 STORMS PER YEAR)

TABLE III-4 (Cont'd.)
ENVIRONMENTAL FORECASTING DATA PRODUCTS DESCRIPTION AND CHARACTERISTICS

DATA PRODUCT	CONTENTS	FORMAT	GEOGRAPHIC COVERAGE	DATA BASE USED TO PRODUCE PRODUCT	DATA USED IN PRODUCT	VOLUME PER TRANSMISSION TO CUSTOMER	FREQUENCY OF TRANSMISSION TO CUSTOMER	ANNUAL VOLUME DISTRIBUTED TO CUSTOMER
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION - NATIONAL HURRICANE CENTER								
STORM TIDE WARNING BULLETIN OR LOCAL TIDE STATEMENTS	HIGH WATER LEVELS, PEAKS, TIMES, & SIGNIFICANT BEACH EROSION	BULLETINS - NO SET FORMAT	U.S. COASTAL AREAS INCLUDING HAWAII & PUERTO RICO	HISTORICAL RECORDS AT EACH CENTER, & TIDE TABLES	STORM SYSTEM LOCATION, WIND VELOCITIES & DURATION, TIDE DATA, SEA & SWELL FORECASTS	VARIES	FOUR TIMES DAILY PER STORM & LOCAL STATEMENTS	UNKNOWN - AN AVERAGE [illegible] STORMS PER YEAR
SURF FORECASTS	QUANTITIVE FORECASTS OF WAVE & SURF HEIGHTS & WAVE PERIODS. QUALITATIVE FORECASTS OF SEA STATE & [illegible] CONDITIONS	NOT FIXED	SOUTHERN CALIFORNIA BEACH AREAS FROM PT. CONCEPTION TO THE MEXICAN BORDER	NONE	LOCAL WEATHER REPORTS, FORECASTS OF SEA AND SWELL, SURFACE WIND ANALYSES AND FORECASTS, SURF & SWELL MEASUREMENTS, [illegible] BEACH SLOPE	SURF FORECASTS FOR [illegible] BEACH AREAS	ONCE A DAY	[illegible]
NATIONAL TSUNAMI WARNING SYSTEM (COAST AND GEODETIC SURVEY)								
TSUNAMI WARNINGS	DESCRIPTION OF TIME & LOCATION OF EARTHQUAKE; COMPUTED TIME OF ARRIVAL AT VARIOUS TIDE STATIONS	NOT FIXED	PACIFIC BASIN	DETECTED TSUNAMIS, TRAVEL TIME CHARTS	REPORTS FROM SEISMIC STATIONS & TIDE MEASURING STATIONS; OCEAN [illegible]	AVERAGE [illegible] BULLETINS (WARNINGS) PER [illegible] DISTURBANCE	FOUR TIMES YEARLY (AVERAGE FOR LAST [illegible] YEARS)	AVERAGE OF 12 BULLETINS PER YEAR
NATIONAL ENVIRONMENTAL SATELLITE CENTER								
SATELLITE RELATED PRODUCTS (IMAGERY	SNOW & ICE BOUNDARY CHARTS, DIGITIZED MAPPED MOSAICS, ANALOG GRIDDED PICTURES, MEAN BRIGHTNESS CHARTS. FUTURE: SEA SURFACE TEMPERATURE CHARTS, VERTICAL [illegible] OF ATMOSPHERE, DERIVED WIND DATA	MOSAICS OF [illegible] ON [illegible] & STEREOGRAPHIC PROJECTIONS. INDIVIDUAL FRAMES ON A MERCATOR GRID. FUTURE: SST DATA IN [illegible] IN NWP GRID FORMAT, TEMPERATURE PROFILE DATA IN NWP GRID FORMAT, WIND FIELD CHARTS	GLOBAL	POLAR & MERCATOR. MAPPED PHOTOS. PRIMITIVE EQUATION MERCATOR [illegible] FOR [illegible] DATA VERIFICATION	DATA BASE CONSISTS OF ORBITAL ELEMENTS, ALL DATA REMOTELY SENSED & TRANSMITTED EARTHWARD	DAILY [illegible] COMPUTER PRODUCTS, [illegible] MANUAL PRODUCTS, & [illegible] PHOTO PRODUCTS	DAILY ON AN ESTABLISHED SCHEDULE	[illegible] PRODUCTS. IN ADDITION, IN 1967 [illegible] SATELLITE STORM ADVISORIES & [illegible] MISCELLANEOUS SATELLITE [illegible]
FLEET NUMERICAL WEATHER CENTRAL								
OCEANOGRAPHIC & METEOROLOGICAL ANALYSES & FORECASTS (RESEARCH STUDIES [illegible] DAY FORECASTS FROM ANALOG MODELS)	OCEANOGRAPHIC: WIND WAVES, SWELL, CURRENTS, FRONTS, TRANSPORT, THERMAL STRUCTURE, SOUND VELOCITY PROFILE, RANGE PREDICTION, PROPAGATION LOSS, (10 DAY SEA HEIGHT FOR SHIP ROUTING). METEOROLOGICAL: FORECASTS, OBJECTIVE FRONTS, CONTROL PROBABILITY, CLEAR AIR TURBULENCE, HURRICANE PATH, (10 DAY ANALOG FORECAST, RESEARCH NOTES)	COMPUTER PREPARED MESSAGES, COMPUTER PLOTTED CHARTS, DATA FIELDS, SPOT DATA FORMAT, & DESIGNATED POINTS ON REQUEST	NORTHERN HEMISPHERE. SELECTED POINTS IN NORTHERN HEMISPHERE	NEDN, AWN, ADIS NETWORK REPORTS	ALL AVAILABLE RECENT SYNOPTIC DATA	[illegible]	12 HOURLY	UP TO [illegible] PRODUCTS

The annual volumes indicated for the warning and advisory products are historical means and may vary significantly in different years.

PROJECTED REQUIREMENTS FOR FORECASTING PRODUCTS

Growth in the rate of production of forecasting products will occur in response to changing requirements of the various user communities. User demands may cause changes in three aspects of forecasting products: (1) a change in the total volume of production of existing products, (2) a change in the content of a product (e.g., detail, coverage), and (3) the preparation of new products. Constraints which will limit these future changes include data availability, state of the art of forecasting, availability and cost of data communications, and cost/benefit considerations concerned with both user requirements and response capabilities of the producing agencies.

The major predictable component of growth in volume of products will result from an increase in the frequency and geographic coverage of existing products. For example, the expansion of surf forecasts from one per day for five Southern California beaches to 14 per day to cover all coastal areas of the United States would result in a major increase in product volume. Increased coverage (and greater detail) in oceanographic forecasts of thermal structure and surface temperatures will have the same effect.

Recommendations are contained in the next chapter for the preparation of several new products. The implementation of these recommendations will significantly affect total product volume; however, it is not possible at this time to estimate the schedule for production of these products. It appears certain that, as knowledge of the oceans increases the preparation of additional new forecasting products will be possible, and these products may be required for both existing and new industrial, engineering, military and fishing activities. The impact of these new products may be significant. However, it is not possible to estimate the effect of these new products without knowledge of their utility.

An example is the current estuarine flushing prediction, being prepared on a trial basis for the Penobscot Estuary in Maine. A detailed evaluation of this program is required prior to the preparation of product growth estimates. All new products will require similar evaluation.

The projected annual volumes of forecasting products are indicated in Table III-5. The current volume figures (for 1968) are derived from information contained in Table III-4. The projections are based on a continuing increase in user demand, technological advances in data acquisition and service operations, and increases in the coverage of some products. No significant increase in the mean volume of warning and advisory products is expected. Standard weather forecasting products will grow at a very limited rate. The impact of new products on total volume is not included in the table.

DESCRIPTIVE PRODUCTS REQUIREMENTS

CURRENT PRODUCTION

Marine descriptive products fall into five general categories: (1) historical, (2) physical, (3) navigational, (4) fishery and biological, and (5) engineering. Historical products include climatological atlases, sea and swell atlases, ice atlases, ocean station atlases, etc. The preparation of these products requires the acquisition and storage of large quantities of observational data, covering broad geographic areas and extended periods of time. If these historical data are adequate and the environment is not undergoing a continuing change (e.g., earth magnetics), the products will have an indefinite period of validity. Periodic updating of existing products may be required as new or more reliable data accumulate, and new products may be produced when sufficient data are available. These new products may either cover geographic areas previously inadequately described, or they may present the mean state of characteristics for which data were not previously collected or utilized. Many of the oceanographic atlases fall into the first category, while products such as bottom

TABLE III-5

ENVIRONMENTAL FORECASTING DATA PRODUCTS CURRENT AND PROJECTED REQUIREMENTS

PRODUCT	PRODUCERS	USERS	CURRENT VOLUME	PROJECTED ANNUAL VOLUMES										
				FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79	FY 80	TOTAL
HEMISPHERIC WEATHER CHARTS (ANALYSES AND PROGNOSES)	NMC	EF, MS, ED	575 TRANSMISSIONS PER DAY*	210 X10^3	210 X10^3	214 X10^3	214 X10^3	218 X10^3	218 X10^3	222 X10^3	222 X10^3	226 X10^3	226 X10^3	2.18 X10^6
	FNWC	EF, NO, MS	308 TRANSMISSIONS PER DAY	112.5 X10^3	112.5 X10^3	115 X10^3	115 X10^3	117 X10^3	117 X10^3	119 X10^3	119 X10^3	121 X10^3	121 X10^3	1.17 X10^6
		TOTALS	883 TRANSMISSIONS PER DAY	322.5 X10^3	322.5 X10^3	329 X10^3	329 X10^3	335 X10^3	335 X10^3	341 X10^3	341 X10^3	347 X10^3	347 X10^3	3.35 X10^6
WAVE HEIGHT FORECASTS	NMC	EF, MS	20 TRANSMISSIONS PER DAY	7.3 X10^3	7.3 X10^3	7.3 X10^3	8.8 X10^3	8.8 X10^3	8.8 X10^3	10.2 X10^3	10.2 X10^3	10.2 X10^3	10.2 X10^3	89.1 X10^3
	FNWC	EF, NO, MS	30 TRANSMISSIONS PER DAY	11.0 X10^3	11.0 X10^3	11.0 X10^3	12.4 X10^3	12.4 X10^3	12.4 X10^3	14.0 X10^3	14.0 X10^3	14.0 X10^3	14.0 X10^3	126.2 X10^3
		TOTALS	50 TRANSMISSION PER DAY	18.3 X10^3	18.3 X10^3	18.3 X10^3	21.2 X10^3	21.2 X10^3	21.2 X10^3	24.2 X10^3	24.2 X10^3	24.2 X10^3	24.2 X10^3	215.3 X10^3
EXTENDED RANGE WEATHER FORECASTS	NMC	EF, MS	3 FORECASTS PER WEEK	365	365	365	365	365	730	730	730	730	730	2.29 X10^3
	FNWC	EF, NO, MS	3 FORECASTS PER WEEK	156	156	156	208	208	208	260	260	260	365	2.24 X10^3
		TOTALS	6 FORECASTS PER WEEK	312	312	312	416	416	416	520	520	572	730	4.53 X10^3
COASTAL WEATHER & WAVE FORECASTS	WB (18) AREA FORECAST CENTERS	MS, OE, IO, F, R, P&M, PAL	72 FORECASTS PER DAY	26.3 X10^3	26.3 X10^3	26.3 X10^3	27.7 X10^3	27.7 X10^3	27.7 X10^3	29.2 X10^3	29.2 X10^3	29.2 X10^3	29.2 X10^3	278.8 X10^3
	FWC'S	NO, MS, OE	30 FORECASTS PER DAY	10.9 X10^3	10.9 X10^3	10.9 X10^3	12.4 X10^3	12.4 X10^3	12.4 X10^3	12.4 X10^3	13.9 X10^3	13.9 X10^3	13.9 X10^3	124.0 X10^3
		TOTALS	102 FORECASTS PER DAY	37.2 X10^3	37.2 X10^3	37.2 X10^3	40.1 X10^3	40.1 X10^3	40.1 X10^3	41.6 X10^3	43.1 X10^3	43.1 X10^3	43.1 X10^3	402.8 X10^3
HIGH SEAS WEATHER FORECASTS	WB-MFC'S (3)	MS, OE	12 FORECASTS PER DAY	4.4 X10^3	4.4 X10^3	4.4 X10^3	4.4 X10^3	5.5 X10^3	5.5 X10^3	5.5 X10^3	5.5 X10^3	5.5 X10^3	6.6 X10^3	51.7 X10^3
	FWC'S	NO, MS, OE	24 FORECASTS PER DAY	8.8 X10^3	8.8 X10^3	8.8 X10^3	10.2 X10^3	10.2 X10^3	10.2 X10^3	11.7 X10^3	11.7 X10^3	11.7 X10^3	11.7 X10^3	10[illegible].8 X10^3
		TOTALS	36 FORECASTS PER DAY	13.2 X10^3	13.2 X10^3	13.2 X10^3	14.6 X10^3	15.7 X10^3	15.7 X10^3	17.2 X10^3	17.2 X10^3	17.2 X10^3	18.3 X10^3	153.5 X10^3

PRODUCERS
- NMC - National Meteorological Center
- FNWC - Fleet Numerical Weather Central
- WB - Weather Bureau
- WB-MFC - Marine Forecast Centers
- FWC - Fleet Weather Centrals
- NESC - National Environmental Satellite Center
- NAVOCEANO - Naval Oceanographic Office
- C&GS - Coast and Geodetic Survey
- BCF - Bureau of Commercial Fisheries

*Includes both marine and non-marine transmissions.

USER COMMUNITIES
- EF - Environmental Forecasting
- ED - Environmental Description
- NO - Naval Operations
- MS - Merchant Shipping
- OE - Ocean Engineering
- IO - Industrial Operations
- F - Fishing
- REC - Recreation
- E - Education
- P&M - State and Regional Planning & Management
- R - Research
- PAL - Public at large

TABLE III-5 (Cont'd.)
ENVIRONMENTAL FORECASTING DATA PRODUCTS CURRENT AND PROJECTED REQUIREMENTS

PRODUCT	PRODUCERS	USERS	CURRENT VOLUME	PROJECTED ANNUAL VOLUMES FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79	FY 80	TOTAL
STORM SURGE ADVISORIES	WB AREA FORECASTING CENTERS (6)	F, P&M, PAL, REC, IO, MS, OE, NO	350 ADVISORIES PER YEAR	350	350	350	350	385	385	385	385	385	[illegible]	3710
TROPICAL CYCLONE ADVISORIES	WB-HURRICANE WARNING OFFICES NWS	F, P&M, PAL, REC, IO, MS, OE, NO	[illegible] ADVISORIES PER YEAR (44 STORMS)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6000 X10^{3}
SURF FORECASTS	WB OFFICES MISC	R, PAL, OE,	1 FORECAST PER DAY (LA)	365	365	730	[illegible]	[illegible]	[illegible]	1825	[illegible]	[illegible]	[illegible]	[illegible]
TSUNAMI WARNINGS	TSUNAMI WARNING CENTERS	PAL, P&M, IO, OE, F, REC, MS, NO	12 BULLETINS PER YEAR	12	12	12	12	12	12	12	[illegible]	[illegible]	[illegible]	[illegible]
SATELLITE REMOTE SENSOR PRODUCTS	[illegible]	[illegible]	[illegible] CHARTS & PHOTOS PER DAY	[illegible] X10^{3}	38.3 X10^{3}	38.3 X10^{3}	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	51.1 X10^{3}	[illegible]	[illegible]
SEA SURFACE TEMPERATURE CHARTS	[illegible]	FE, ED, F, NO, R	[illegible] CHARTS PER DAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEA ICE FORECASTS	NAVOCEANO [illegible]	NO, MS, OE, IO, F	[illegible] PER YEAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DOMESTIC ICE FORECASTS	[illegible]	MS, NO, F, R, PAL	[illegible] FORECASTS PER YEAR	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
THERMAL STRUCTURE FORECASTS	[illegible]	[illegible]	[illegible] PER DAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] PREDICTIONS	[illegible]	[illegible]	[illegible]											
FISHERY [illegible] REPORTS			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FISHERY ADVISORIES	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]		[illegible]	[illegible]		[illegible]

PRODUCERS [illegible]

USERS [illegible]

temperature atlases, of potential value to fisheries and some industrial operations, and astronomical/meteorological tide atlases would fall into the latter category. The major component of increased volume in historical descriptive products will be from these two sources. This component will be supplemented by the generally increased demand for products resulting from the increasing level of oceanographic activity.

Physical descriptive products include bathymetric maps, gravity maps, magnetic maps, geological maps and reports, etc. The preparation of these products requires the accumulation and storage of extensive survey data for the areas covered. The scale of the maps is dependent on the detail of the survey data. If the data are accurate and an appropriate scale is used, the maps will have validity for an indefinitely long period except in those areas where geological processes may cause short term changes (e.g., filling, shore erosion, vulcanism, seismic activity). The major growth in volume of these products will come from increased coverage of oceanic and coastal areas; however, existing maps will be periodically corrected on the basis of more complete survey data. The user demand for these products is increasing rapidly.

Navigational products include nautical charts, navigation notices, and other products prepared specifically for merchant shipping, defense use, and small craft operators. These products include selected historical and descriptive data, supplemented by information concerning aids to navigation, hazards, anchorages, natural features, onshore and offshore structures, etc. As indicated in the previous chapter, nautical charts are periodically updated, and the notices to mariners include changes of interest to users prior to their incorporation into new editions. The volume of these products will directly reflect user demands.

Fisheries and biological products include fishery statistics reports, other long term products in support of the fishing industry, faunal atlases, biological monographs, etc. The growth in volume of these products will reflect the

demands of the fishing fleets, processors, and wholesalers; the sportsfishing community; resource managers; and the research community. Naval operations also has requirements for biological data.

Engineering products include ocean engineering handbooks, and various other engineering publications and documents. With the growing interest in marine technology and exploration these products will be in greatly increasing demand by the ocean engineering, industrial operations, and naval operations user communities.

Table III-6 contains descriptions of major products produced by the organizations contacted during the Part II study. The total number of copies of the various products currently produced is in most cases a direct function of the existing user demand.

PROJECTED REQUIREMENTS

The projected requirements for selected descriptive products are indicated in Table III-7. The current (1968) volume of the various products is based either on the number of users and the number of specific items included within a product, or on the known number of warnings and editions issued. The volume figures are for total copies produced for the respective years. The growth rates are based on the projected increases in user demand, supplemented by increases in the number of specific items produced. As a group, the navigational products have the greatest total volume, but the lowest projected growth rates. Geological products have the greatest projected growth.

TABLE III-6
DESCRIPTIVE PRODUCTS - DESCRIPTION AND CHARACTERISTICS

DATA PRODUCT	CONTENTS	FORMAT	GEOGRAPHIC COVERAGE	DATA BASE USED TO PRODUCE PRODUCT	DATA USED IN PRODUCT	VOLUME PER TRANSMISSION TO CUSTOMER	FREQUENCY OF TRANSMISSION TO CUSTOMER	ANNUAL VOLUME DISTRIBUTED TO CUSTOMER
NAVAL OCEANOGRAPHIC OFFICE								
BATHYMETRY DATA	PLOTTED & ANALYZED SOUNDING DATA	COLLECTION SHEETS, BOTTOM CONTOUR CHARTS, NONSUBMARINE CONTACT MANUSCRIPTS, PLOTTING SHEETS, IHB GENERAL BATHYMETRIC CHARTS	GLOBAL	NAVOCEANO, BATHYMETRIC FILES	SOUNDINGS, GEOGRAPHIC POSITIONS POSITIONS OF NAVAIDS, HAZARDS, ETC.		ON REQUEST	
GEOMAGNETICS: WORLD MAGNETIC CHARTS (H.O. 1700 SERIES), R&D SUPPORT, ANNUAL GEOMAGNETICS SURVEY, INFORMATION BROCHURE, DUPLICATES OF MAGNETIC DATA RECORDS	HIGH DENSITY CONTOURS OF MAGNETIC FIELD INTENSITY & DIRECTION	CHARTS	WORLDWIDE	GEOMAGNETICS LIBRARY				[illegible]
GRAVITY DATA:								
GRAVITY OBSERVATIONS	POSITION PROCESSED GRAVITY VALUE, SOUNDING, RELATED DATA	EAM CARDS	WORLDWIDE	GRAVITY LIBRARY	GRAVITY RECORDINGS, NAVIGATIONAL DATA, BATHYMETRIC DATA	DUPLICATES OF ALL PROCESSED DATA & RECORDS ARE SENT TO ACIC [illegible] GRAVITY LIBRARY	MONTHLY	SAME AS INPUT VOLUMES
BASE STATION DESCRIPTION SHEETS	INFORMATION FOR CORRELATING RELATIVE-TO-ABSOLUTE VALUES	PREPARED FORM, HAND FILED						
MEAN FREE-AIR ANOMALY	ANOMALY VALUE, GEOGRAPHIC AREA, TIME	EAM CARDS						
DEFLECTION OF THE VERTICAL	AREAL VALUES OF DIFFERENCE BETWEEN THEORETICAL & ACTUAL VERTICAL							
MIS REPORT	PLOTS, INTERPRETATIONS, HOLDINGS, WORK PLANS	[illegible] & NARRATIVES						
H.O. 700, SEC. 5, MARINE GEOLOGY ATLAS	MAJOR PHYSIOGRAPHIC PROVINCES & TECTONIC ZONES, BOTTOM GRADIENTS, TOPOGRAPHY, MATERIALS, EARTHQUAKE & VOLCANO SITES, TYPICAL SEISMIC REFLECTION PROFILES	ATLAS GRAPHIC, SOME TEXT	NORTH ATLANTIC, MEDITERRANEAN SEA, BALTIC SEA, GULF OF MEXICO, & CARIBBEAN SEA	BATHYMETRIC DATA LIBRARY, MAGNETIC DATA LIBRARY, [illegible] REFLECTION PROFILES, [illegible] DATA CENTER, MARINE SEDIMENT DATA COLLECTION	POSITIONS, SOUNDINGS, TOTAL MAGNETIC FIELD, [illegible]	[illegible]	ON REQUEST	[illegible]
H.O. 700, SEC. 4, SOUND VELOCITY ATLAS	SEASONAL SOUND VELOCITY STRUCTURES FOR REGIONS	ATLAS GRAPHIC	NORTH ATLANTIC, MEDITERRANEAN SEA, GULF OF MEXICO, CARIBBEAN SEA, [illegible] SEA	[illegible] SERIAL OCEANOGRAPHIC STATION FILE	SERIAL OCEANOGRAPHIC STATION FILE	[illegible]	ON REQUEST	[illegible]
H.O. 700, SEC. [illegible], TIDES & CURRENTS ATLASES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
H.O. 700, SEC. [illegible], PHYSICAL PROPERTIES ATLAS	TEMPERATURE, SALINITY, & SIGMA-T [illegible] DEPTHS	ATLAS [illegible], SOME TEXT	SAME AS ABOVE	[illegible]	TEMPERATURE, [illegible]	[illegible]	[illegible]	
H.O. 700, SEC. [illegible], ICE ATLAS	[illegible] DATES, [illegible] DATES	ATLAS GRAPHIC, SOME TEXT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
H.O. 700, SEC. [illegible], SEA & SWELL ATLAS	MONTHLY SURFACE WINDS, [illegible] OF SEAS, [illegible] SEAS [illegible] SPEED REDUCTION	ATLAS GRAPHIC, [illegible], SOME TEXT	NORTH ATLANTIC, [illegible] SEA, MEDITERRANEAN SEA	[illegible]	[illegible] SEA STATE, [illegible]	[illegible]	[illegible]	
PILOT CHART	MONTHLY [illegible] WIND ROSES, SELECTED SURFACE CURRENTS, SEA SURFACE TEMPERATURE, FREQUENCY OF FOG, [illegible] GALE REPORTS, & [illegible] LIMITS	GRAPHIC	NORTH PACIFIC, NORTH ATLANTIC, SOUTH ATLANTIC, CENTRAL AMERICAN WATERS, [illegible]	[illegible] SURFACE [illegible] STORM TRACKS, ICE COVERAGE, [illegible] LIBRARY, SURFACE CURRENTS	SURFACE OBSERVATIONS, STORM TRACKS, ICE COVERAGE & [illegible]	[illegible]	[illegible]	[illegible]

TABLE III-6 (Cont'd.)
DESCRIPTIVE PRODUCTS - DESCRIPTION AND CHARACTERISTICS

DATA PRODUCT	CONTENTS	FORMAT	GEOGRAPHIC COVERAGE	DATA BASE USED TO PRODUCE PRODUCT	DATA USED IN PRODUCT	VOLUME PER TRANSMISSION TO CUSTOMER	FREQUENCY OF TRANSMISSION TO CUSTOMER	ANNUAL VOLUME DISTRIBUTED TO CUSTOMER
NAVAL OCEANOGRAPHIC OFFICE								
GRAVITY MAPS (CLASSIFIED)	FREE-AIR [illegible] GRAVITY [illegible]	GRAPHIC	[illegible] AREA [illegible]	GRAVITY DATA LIBRARY [illegible] GRAVITY [illegible] LIBRARY	[illegible]		[illegible]	
MAGNETIC MAPS (ONLY A FEW DETAILED SURVEYS OF SPECIFIC AREAS ARE CLASSIFIED)	MAGNETIC ANOMALY [illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
BATHYMETRIC CHARTS (BATHYMETRIC CHARTS BASED [illegible] SURVEYS [illegible] DETAIL [illegible])	DEPTH CONTOUR	[illegible]	[illegible]	[illegible]			[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]					
[illegible] MAN [illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]							[illegible]
[illegible]								[illegible]
[illegible]							[illegible]	
[illegible]							[illegible]	[illegible]
[illegible]								
[illegible]								
[illegible]	[illegible]						[illegible]	[illegible]
[illegible]	[illegible]							[illegible]

TABLE III-5 (Cont'd.)
DESCRIPTIVE PRODUCTS — DESCRIPTION AND CHARACTERISTICS

DATA PRODUCT	CONTENTS	FORMAT	GEOGRAPHIC COVERAGE	DATA BASE USED TO PRODUCE PRODUCT	DATA USED IN PRODUCT	VOLUME PER TRANSMISSION TO CUSTOMER	FREQUENCY OF TRANSMISSION TO CUSTOMER	ANNUAL VOLUME DISTRIBUTED TO CUSTOMER
NAVY EXPERIMENTAL DIVING UNIT								
ANNUAL SUMMARY REPORT ON U.S. NAVY DIVING ACCIDENTS	SUMMARY OF ACCIDENTS BY GROUPS	REPORT	TOPICAL RATHER THAN GEOGRAPHIC	DIVING ACCIDENT REPORT [illegible]	SAME	INDIVIDUAL REPORT	YEARLY	LIMITED DISTRIBUTION TO NAVY MEDICAL & FLEET UNITS PLUS LIMITED GROUP OF UNIVERSITIES & A FEW INDUSTRIAL FIRMS
RESEARCH REPORTS - SUMMARY STATISTICS: U.S. NAVY DIVING ACCIDENTS	ANALYSIS OF U.S. NAVY DIVING ACCIDENTS OVER [illegible] YEAR PERIOD	REPORT	SAME AS ABOVE	SAME AS ABOVE [illegible]	SAME	SAME AS ABOVE	AS ISSUED	SAME AS ABOVE
TEST & EVALUATION REPORTS ON VARIOUS DIVING EQUIPMENT	SUMMARY OF RESULTS OF EQUIPMENT TESTING & EVALUATION	REPORT	SAME AS ABOVE	DOES NOT APPLY	DOES NOT APPLY	SAME AS ABOVE	AS ISSUED, OR [illegible] GROUP ON ANNUAL BASIS	SAME AS ABOVE
[illegible] AND [illegible] SURVEY								
BATHYMETRIC MAPS [illegible]	DEPTH CONTOURS, [illegible]	[illegible]	[illegible]	BATHYMETRIC DATA	[illegible]	[illegible]	[illegible]	[illegible] PRINTING
TIDE TABLES	TIDE PREDICTION	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TIDAL CURRENT TABLES	TIDAL CURRENT PREDICTIONS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TIDAL CURRENT CHARTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] TABLES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
NAUTICAL CHARTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	

TABLE III-6 (Cont'd.)
DESCRIPTIVE PRODUCTS - DESCRIPTION AND CHARACTERISTICS

DATA PRODUCT	CONTENTS	FORMAT	GEOGRAPHIC COVERAGE	DATA BASE USED TO PRODUCE PRODUCT	DATA USED IN PRODUCT	VOLUME PER TRANSMISSION TO CUSTOMER	FREQUENCY OF TRANSMISSION TO CUSTOMER	ANNUAL VOLUME DISTRIBUTED TO CUSTOMER
[illegible] LAKE SURVEY								
NAVIGATION (NAUTICAL) CHARTS	SELECTED SOUNDINGS, BOTTOM CONTOURS, TOPOGRAPHIC FEATURES, TOPOGRAPHIC CONTOURS, CULTURAL FEATURES & NATURAL FEATURES, AIDS TO NAVIGATION, SHORELINE, LANDMARKS, DANGERS TO NAVIGATION, & SPECIAL AREAS		LAKE OF THE [illegible] GREAT LAKES, LAKE CHAMPLAIN	FIELD SURVEYS SHEETS, [illegible] TO MARINER FILE, [illegible] PONDENCE FILE, LETTERS & ENGINEERING PRINTS	CHART CHANGES & [illegible] NAVIGATION CHANGES, [illegible] AGENCIES' [illegible], AND [illegible]	[illegible] AVERAGE	EVERY [illegible] YEARS & WHEN [illegible]	[illegible],000 CHARTS ([illegible] ISSUES)
FIELD SURVEYS SHEET COPIES	SOUNDINGS, POSITIONS, FIELD LOCATED AIDS TO NAVIGATION & FEATURES	STANDARD [illegible]	GREAT LAKES REGION	FIELD SHEET	[illegible]	[illegible] VARIABLE	[illegible]	[illegible]
GREAT LAKES REGIONAL DATA CENTER								
DATA PRODUCTS [illegible]	WATER LEVEL DATA, WAVE [illegible] DATA, [illegible] CURRENT DATA, [illegible]	VARIABLE	GREAT LAKES [illegible]	WATER LEVEL [illegible]	WATER LEVEL [illegible]	VARIABLE	VARIABLE	[illegible] DATA, [illegible]
[illegible]								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]								
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	

TABLE III-6(Cont'd.)
DESCRIPTIVE PRODUCTS - DESCRIPTION AND CHARACTERISTICS

DATA PRODUCT	CONTENTS	FORMA	GEOGRAPHIC COVERAGE	DATA BASE USED TO PRODUCE PRODUCT	DATA USED IN PRODUCT	VOLUME PER TRANSMISSION TO CUSTOMER	FREQUENCY OF TRANSMISSION TO CUSTOMER	ANNUAL VOLUME DISTRIBUTED TO CUSTOMER
U.S. GEOLOGICAL SURVEY								
TOPOGRAPHIC MAPS VARIOUS SERIES	TOPOGRAPHY, DRAINAGE, CULTURAL FEATURES OF LAND SURFACE, VARIOUS SCALES		[illegible]	[illegible]	FIELD SURVEY MATERIALS & AIR PHOTO INTERPRETED DATA, & GEODETIC CONTROL DATA		PROBABLY MORE THAN 500/YEAR	[illegible] MAPS PER YEAR, PROBABLY 45% ARE TOPOGRAPHIC MAPS
HYDROLOGIC ATLASES	MAPS WHICH EMPHASIZE AREAL EXTENT & FREQUENCY OF FLOODING		SAME AS ABOVE	WATER RESOURCES [illegible] FILES	STREAM DISCHARGE DATA & TOPOGRAPHIC DATA			
[illegible]								
PHYSICAL & CHEMICAL DATA REPORTS; CURRENT MEASUREMENTS ON PUNCHED CARDS; PROFESSION-PAPERS	CORRECTED PROCESSED DATA INCLUDING (IN SOME CASES) ACTUAL STD'	[illegible] - WILL PUT ON TAPE FOR OUTPUT	PER EXPEDITION	[illegible] GENERATED DATA	[illegible]	1 REPORT [illegible]	[illegible]	APPROXIMATELY [illegible]
GLOBAL TIDAL CONSTANTS	AMPLITUDES & FREQUENCIES OF FOURIER COMPONENTS OF TIDES AT ANY PORT OR GEOGRAPHIC ARC	MAGNETIC TAPE & PUNCHED CARDS	ANY [illegible]	[illegible]	[illegible]	NOT KNOWN	[illegible]	NOT KNOWN
STD CORE & ROCK LISTS	LOCATION, SIZE, NATURE, PRELIMINARY DESCRIPTION OF SAMPLES	LISTING IN BOUND [illegible]	[illegible] DEEP [illegible]	[illegible]	[illegible]	[illegible] PER CRUISE, [illegible]	[illegible] YEAR	APPROXIMATELY 350 LISTINGS
REPORTS ON MARINE FOOD WEB STUDIES	INTERDISCIPLINARY STUDY OF EARLY STAGE OF THE FOOD WEB	PUBLISHED DATA RECORDS, [illegible] SIGNAL PAPER	SELECTED [illegible] OF NORTH [illegible] SOUTH [illegible]	[illegible]	[illegible] DATA, [illegible] GENERATED RECORDS	[illegible], DATA [illegible] DATA [illegible]	DATA [illegible] PROFESSIONAL PAPERS, IRREGULAR	VARIES

TABLE III-7
ENVIRONMENTAL DESCRIPTION DATA PRODUCTS - CURRENT AND PROJECTED REQUIREMENTS
(AT EXISTING PERFORMANCE LEVELS)

PRODUCT	PRODUCERS	USERS	CURRENT ANNUAL VOLUME	PROJECTED ANNUAL VOLUMES (TOTAL COPIES)										
				FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79	FY 80	TOTAL
CLIMATOLOGICAL ATLASES	PAST PRODUCERS NAVY HYDROGRAPHIC OFFICE WEATHER BUREAU NAVAL WEATHER SERVICE [illegible]	ALL USER COMMUNITIES	[illegible] COPIES	[illegible]	2600	2700	2800	2900	3000	3200	3300	3400	3600	30 X10[3]
SEA AND SWELL ATLASES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SURFACE CURRENT ATLASES	NAVOCEANO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEA SURFACE TEMPERATURE ATLASES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ICE ATLASES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCEAN STATION ATLASES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BATHYMETRIC MAPS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
GRAVITY FIELD MAPS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FISHERY STATISTICS REPORTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TIDE TABLES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TIDAL CURRENT TABLES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TIDAL CURRENT CHARTS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TEMPERATURE AND DENSITY TABLES	C&GS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

PRODUCERS
- NMC - National Meteorological Center
- FNWC - Fleet Numerical Weather Central
- WB - Weather Bureau
- WB-MFC - Marine Forecast Centers
- FWC - Fleet Weather Centrals
- NESC - National Environmental Satellite Center
- NAVOCEANO - Naval Oceanographic Office
- C&GS - Coast and Geodetic Survey
- BCF - Bureau of Commercial Fisheries
- EDS - Environmental Data Service

USER COMMUNITIES
- EF - Environmental Forecasting
- ED - Environmental Description
- NO - Naval Operations
- MS - Merchant Shipping
- OE - Ocean Engineering
- IO - Industrial Operations
- F - Fishing
- REC - Recreation
- E - Education
- [illegible] - State and Regional Planning & Management
- PAL - Public at Large

SYNTHESIS OF DATA REQUIREMENTS

The growth in demand for marine data collection as discussed in the previous section will result in greatly increased annual volumes by 1980, with the accompanying need for management systems to effectively handle these data. The increased volume will be the result of growing requirements from all user communities; however, the growth rates for the various data types will differ. The data required for the production of existing products, both forecasting and descriptive, will generally have a growth in annual volume ranging between 50 percent and 100 percent. The annual volume of a few data types will greatly exceed this growth rate (200 percent total growth rate for the parameters considered in Table III-3) as new platforms become available, and as new products are established in response to new user demands. The overall effect will be a continuing compounding of the requirements for data acquisition and processing systems.

The characteristics of data acquisition systems are a function of the use of the data. Data collected for environmental forecasting purposes rapidly become obsolete, while accuracy, detail, and coverage assume greater importance in data collected for environmental description purposes. Research data acquisition systems have somewhat different requirements, as do those networks concerned primarily with engineering data. The major characteristics of these systems are: (1) the frequency of data input, (2) the timeliness of data input, (3) the range of the parameters for which data are collected, (4) the density of data collection, (5) the geographic coverage of the collected data, and (6) the accuracy of the data.

The projected requirements for various types of data are indicated in Table III-8 for forecasting (FCSTG.) and descriptive (DESCR.) applications. Data input frequency and timeliness are critical characteristics only for forecasting use of the data. Projected changes in the requirements of these characteristics will result from modifications of existing forecasting products, the

TABLE III-8

DATA ACQUISITION REQUIREMENTS FOR ENVIRONMENTAL FORECASTING AND ENVIRONMENTAL DESCRIPTION USE FOR THE PERIODS FY 71-75 AND FY 76-80

PARAMETER	UNITS	APPLICATIONS	INPUT FREQUENCY		INPUT TIMELINESS		PARAMETER RANGE		COLLECTION DENSITY		GEOGRAPHIC COVERAGE		MEASUREMENT ACCURACY*	
			71-75	76-80	71-75	76-80	71-75	76-80	71-75	76-80	71-75	76-80	71-75	76-80
TEMPERATURE, SEA SURFACE AND BATHYTHERMOGRAPH	[illegible]	FCSTG.**	2-4/DAY	2-4/DAY	2-12 HRS.	2-12 HRS.	-5°/+35°	-5°/+40°	VAR.	100-500 MILE GRID	N. HEMISPHERE	ALL OCEANS	0.02	0.01
		DESCR.***	ANNUAL	ANNUAL	WEEKS	WEEKS	SAME	SAME	SAME	SAME	SAME	SAME	SAME	SAME
CURRENTS, DIRECTION AND VELOCITY	DEG., KNOTS	FCSTG.	VAR.	DAILY	--	24 HRS	--	--	--	--	SELECTED AREAS	SELECTED AREAS	.03	.03
		DESCR.	ANNUAL	ANNUAL	--	WEEKS	--	--	--	--	SAME	SAME	SAME	SAME
TIDES, LEVEL AND PERIOD	FT.	FCSTG.	WEEKLY AND MONTHLY	WEEKLY	WEEKS	HOURS	0-60	0-60	--	--	--	(INCLUDE REMOTE AREAS)	0.1	0.05
		DESCR.	ANNUAL	ANNUAL	MONTHS	WEEKS	SAME	SAME	--	--	--	SAME	0.1	0.05
WAVES, HEIGHT, PERIOD, LENGTH, DIRECTION	FT.	FCSTG.	4/DAY	4-8/DAY	2 HRS	2 HRS	0-100	0-100	--	(INCREASE)	N. HEMISPHERE	(INCREASE)	5%	1%
		DESCR.	ANNUAL	ANNUAL	WEEKS	WEEKS	SAME	SAME	--	(INCREASE)	SAME	(INCREASE)	SAME	SAME
SWELL, PERIOD, HEIGHT, DIRECTION	FT.	FCSTG.	4/DAY	4-8/DAY	2 HRS	2 HRS	0-100	0-100	--	(INCREASED OCEANIC)	N.HEMISPHERE	(INCREASED OCEANIC)	5%	1%
		DESCR.	ANNUAL	ANNUAL	--	--	SAME	SAME	--	SAME	SAME	SAME	SAME	SAME
SALINITY	0/00	FCSTG.	4/DAY	4/DAY	12 HRS	12 HRS	0.01-40	0.01-40	--	--	SELECTED AREAS	ALL OCEANS	.01	.01
		DESCR.	ANNUAL	ANNUAL	WEEKS	WEEKS	0.01-40	0.01-40	--	--	SAME	SAME	.01	.01
OXYGEN, DISSOLVED	ML/L	DESCR.	VAR.****	VAR.	MONTHS	WEEKS	0.5-4.0	0.5-4.0	VAR.	VAR.	SPECIAL AREAS	SELECTED AND COASTAL	0.05	0.01
SEDIMENTS, DEPOSITION	--	DESCR.	VAR.	VAR.	YEARS	MONTHS	--	--	VAR.	VAR.	SELECTED AREAS	ALL OCEANS	--	--
SEDIMENTS, TRANSPORT, ETC.	--	DESCR.	VAR.	VAR.	MONTHS	MONTHS	--	--	--	--	SELECTED AREAS	SELECTED AREAS	--	--
SEISMIC, REFLECTION, ETC.	--	DESCR.	VAR.	VAR.	YEARS	MONTHS	--	--	--	--	SELECTED AREAS	INCREASE	--	--
SPECIES, DISTRIBUTION, ABUNDANCE, ETC.	--	DESCR.	NA	NA	MONTHS	MONTHS	NA	NA	VAR.	VAR.	SELECTED AREAS	ALL OCEANS	NA	NA
PIGMENTS		DESCR.	NA	NA	MONTHS	MONTHS	--	--	--	--	SELECTED AREAS	ALL OCEANS	-- --	-- --
CATCH EFFORT	--	FCSTG.	DAILY	DAILY	6 HRS	6 HRS	NA	NA	VAR.	VAR.	SELECTED FISHING AREAS	ALL MAJOR FISHING AREAS	NA	NA
		DESCR.	SEASON	SEASON	WEEKS	WEEKS	NA	NA	VAR.	VAR.	SAME	SAME	NA	NA

*Attainable Instrument Accuracies. This degree of accuracy may not always be required for making forecasts.

**FCSTG. = Forecasting

***DESCR. = Descriptive

****VAR. = Variable

TABLE III-8 (Cont'd.)

DATA ACQUISITION REQUIREMENTS FOR ENVIRONMENTAL FORECASTING AND ENVIRONMENTAL DESCRIPTION USE FOR THE PERIODS FY 71-75 AND FY 76-80

PARAMETER	UNITS	APPLICATIONS	INPUT FREQUENCY		INPUT TIMELINESS		PARAMETER RANGE		COLLECTION DENSITY		GEOGRAPHIC COVERAGE		MEASUREMENT ACCURACY*	
			71-75	76-80	71-75	76-80	71-75	76-80	71-75	76-80	71-75	76-80	71-75	76-80
AIR CHARACTERISTICS, TEMPERATURE, PRESSURE, HUMIDITY	--	FCSTG.**	4-8/DAY	4-8/DAY	2 HRS	2 HRS	--	--	--	(INCREASED OCEANIC)	N.HEMISPHERE	(INCREASED OCEANIC)	--	--
		DESCR.***	ANNUAL	ANNUAL	--	--	--	--	--	SAME	SAME	SAME	--	--
WINDS, SPEED, DIRECTION	KNOTS	FCSTG.	4-8/DAY	4-8/DAY	2 HRS	2 HRS	0-160	0-160	--	SAME	N.HEMISPHERE	SAME	1.0	1.0
		DESCR.	ANNUAL	ANNUAL	--	--	--	--	--	SAME	SAME	SAME	SAME	SAME
CLOUDS, COVER, TYPE, ALTITUDE	0/0, FT.	FCSTG.	4-8/DAY	4-8/DAY	2 HRS	2 HRS	--	--	--	(INCREASED OCEANIC)	--	(INCREASED OCEANIC)	--	--
		DESCR.	ANNUAL	ANNUAL	--	--	--	--	--	SAME	--	SAME	--	--
PRECIPITATION, AMOUNT, TYPE	INCHES	FCSTG.	4-8/DAY	4-8/DAY	2 HRS	2 HRS	--	--	--	(INCREASED OCEANIC)	--	(INCREASED OCEANIC)	--	--
		DESCR.	ANNUAL	ANNUAL	--	--	--	--	--	SAME	--	SAME	--	--
NUTRIENTS, TYPE, CONCENTRATION	MG/L	DESCR.	VAR.****	VAR.	MONTHS	WEEKS	?	?	--	(INCREASE)	--	(COASTAL AND OCEANIC)	?	?
OIL & GREASE	--	DESCR.	VAR.	VAR.	MONTHS	DAYS	--	--	(OUTFALLS)	(COASTAL)	(OUTFALLS)	(COASTAL)	--	--
PESTICIDES	0/000	DESCR.	VAR.	WEEKLY	YEARS	MONTHS	?	?	(OUTFALLS)	(COASTAL)	(OUTFALLS)	(COASTAL AND OCEANIC)	--	--
SOLID WASTES	0/00	DESCR.	VAR.	WEEKLY	MONTHS	WEEKS	--	--	(OUTFALLS & DUMPS)	(COASTAL)	(OUTFALLS & OFFSHORE)	(COASTAL)	--	--
WASTE HEAT	BTUS	DESCR.	VAR.	WEEKLY	MONTHS	DAYS	--	--	(OUTFALLS)	(OUTFALLS & VICINITY)	(OUTFALLS)	(OUTFALLS & VICINITY)	--	--
MICROBIAL, BACTERIA, VIRUS	MPN	DESCR.	VAR.	WEEKLY	DAYS	DAYS	--	--	(OUTFALLS)	(OUTFALLS)	(OUTFALLS)	(OUTFALLS)	--	--
WAVE DATA (ENGINEERING)	-- (FORCE)	DESCR.	VAR.	VAR.	-- --	--	--	--	--	--	SELECTED SITES	SELECTED SITES		

*Attainable Instrument Accuracies. This degree of accuracy may not always be required for making forecasts.
**FCSTG. = Forecasting
***DESCR. = Descriptive
****VAR. = Variable

TABLE III-8 (cont'd.)

DATA ACQUISITION REQUIREMENTS FOR ENVIRONMENTAL FORECASTING AND ENVIRONMENTAL DESCRIPTION USE FOR THE PERIODS FY 71-75 AND FY 76-80

PARAMETER	UNITS	APPLI-CATIONS	INPUT FREQUENCY		INPUT TIMELINESS		PARAMETER RANGE		COLLECTION DENSITY		GEOGRAPHIC COVERAGE		MEASUREMENT ACCURACY*	
			71-75	76-80	71-75	76-80	71-75	76-80	71-75	76-80	71-75	76-80	71-75	76-80
WIND DATA (ENGINEERING)		DESCR.**	VAR.***	VAR.	--	--	(0-160 KNOTS)	(0-160 KNOTS)	--	--	SELECTED SITES	SELECTED SITES		
CURRENT DATA (ENGINEERING)		DESCR.	VAR.	VAR.	--	--	0-10 KNOTS	0-10 KNOTS	--	--	SELECTED AREAS	SELECTED AREAS	.03	.03
MATERIALS DATA		DESCR.	VAR.	VAR.	--	--	--	--	--	--	--	--	--	--
BOTTOM PROPERTIES		DESCR.	VAR.	VAR.	--	--	--	--	--	--	SELECTED AREAS	SELECTED AREAS	--	--
ACOUSTIC, REFLECTION, FREQUENCY, ETC.	--	DESCR.	VAR.	VAR.	--	--	--	--	--	--	SELECTED AREAS	SELECTED AREAS	--	--
ELECTROMAGNETICS		DESCR.	VAR.	VAR.	--	--	--	--	--	--	SELECTED AREAS	SELECTED AREAS	--	--
OPTICS, ABSORPTION, SCATTERING, ETC.		DESCR.	VAR.	VAR.	--	--	--	--	--	--	SELECTED AREAS	SELECTED AREAS	--	--
SEA ICE, LOCATION, DIRECTION, ETC.		FCSTG.****	VAR.	VAR.	24 HRS	24 HRS	--	--	--	--	NORTH ATLANTIC	NORTH ATLANTIC AND ARCTIC	--	--
		DESCR.	ANNUAL	ANNUAL	--	--	--	--	--	--	NORTH ATLANTIC	NORTH ATLANTIC AND ARCTIC	--	--

*Attainable Instrument Accuracies. This degree of accuracy may not always be required for making forecasts.

**DESCR. = Descriptive

***VAR. = Variable

****FCSTG. = Forecasting

implementation of new products (e.g., current forecasts, combined astronomical/ meteorological tide predictions), and future deviations from synoptic methods of forecasting. The density and geographic coverage of data collection are critical characteristics for both forecasting and descriptive products. A major component of the projected increase of volume of data collection will be the result of the effort to satisfy existing and future needs in those two areas. New products will also require the increased measurement of pertinent parameters. The density and geographic coverage requirements for these new data will provide most of the remaining projected increases in total data volume. The remaining growth will result from increased research, engineering, and industrial activities.

The size of future data collection volumes has an impact on both the collector of the data and the data service facilities which maintain data bases. In order to determine the effect on data service facilities of future data volumes, Table III-9 has been constructed. This table compares the demand for selected data parameters over the next 10 years with the amount of data which would be collected if the volume of data collected were to remain constant at FY 69 levels. The latter quantity is called the "current supply" in the table. The difference between the demand for data and the amount which can be supplied at current collection rates is shown in the table for the next 10 years. In addition, the table shows the cumulative amount of additional data which is required over existing levels for each year.

The difference between data demand and current supply is the amount of new data volumes which will be added to the national data bases in addition to those data which will be added by the existing collection system. For example, it is projected that a total of 20.26 million sea surface temperature observations will be acquired over the next 10 years. Of this amount, 10.20 million (1.02X10) of the observations represent data which can be provided by existing data collection capabilities and 10.06 million observations represent data which must be provided by an augmentation of existing data collection capabilities. These

TABLE III-9
COMPARISON OF DEMAND WITH SUPPLY FOR SELECTED DATA PARAMETERS

UNITS		71	72	73	74	75	76	77	78	79	80	TEN YEAR TOTALS	MILLIONS OF BCD CHARACTERS REQUIRED
PHYSICAL AND CHEMICAL MEASUREMENTS													
SEA SURFACE TEMPERATURE OBSERVATIONS													
MILLIONS OF OBSERVATIONS	FUTURE DEMAND	1.62	1.75	1.86	1.91	1.99	2.04	2.10	2.21	2.33	2.45	20.26	60.78
	CURRENT SUPPLY*	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02		
	ANNUAL DEFICIENCY	.60	.73	.84	.89	.97	1.02	1.08	1.19	1.31	1.43		
	CUMULATIVE DEFICIENCY	.60	1.33	2.17	3.06	4.03	5.05	6.13	7.32	8.63	10.06		30.18
SEA TEMPERATURE PROFILES (BT AND XBT)													
THOUSANDS OF CHARTS	FUTURE DEMAND	543	636	647	654	666	674	677	688	700	712	6594	527.52
	CURRENT SUPPLY*	296	296	296	296	296	296	296	296	296	296		
	ANNUAL DEFICIENCY	247	340	351	358	370	375	381	392	440	416		
	CUMULATIVE DEFICIENCY	247	587	938	1296	1666	2041	2422	2814	3218	3634		290.72
STD RECORDINGS													
THOUSANDS OF RECORDINGS	FUTURE DEMAND	47.8	58.4	67.3	73.0	78.[illegible]	83.0	87.6	92.0	96.0	99.7	782.8	125.25
	CURRENT SUPPLY*	45.3	45.3	45.3	45.3	45.3	45.3	45.3	45.3	45.3	45.3		
	ANNUAL DEFICIENCY	2.5	13.1	22.0	27.7	32.7	37.7	42.3	46.7	50.7	54.4		
	CUMULATIVE DEFICIENCY	2.5	15.6	37.6	[illegible]	98.0	135.7	178.0	224.7	275.4	329.8		52.77
NANSEN CASTS													
THOUSANDS OF CASTS	FUTURE DEMAND	8.25	9.00	9.63	10.19	10.81	11.38	12.00	12.63	13.19	13.75	110.83	17.73
	CURRENT SUPPLY*	6.17	6.17	6.17	6.17	6.17	6.17	6.17	6.17	6.17	6.17		
	ANNUAL DEFICIENCY	2.08	2.83	3.46	4.02	4.64	5.21	5.83	6.46	7.02	7.58		
	CUMULATIVE DEFICIENCY	2.08	4.91	8.37	12.39	17.03	22.24	28.07	34.53	41.55	49.13		7.86
CURRENT MEASUREMENTS													
THOUSANDS OF METER HOURS	FUTURE DEMAND	[illegible]	[illegible]	[illegible]	[illegible]	84.0	88.0	[illegible]	95.0	99.0	103.0	847.6	42.38
	CURRENT SUPPLY*	[illegible]	[illegible]	[illegible]	46.0	[illegible]	[illegible]	[illegible]	46.0	[illegible]	46.0		
	ANNUAL DEFICIENCY	15.0	23.0	[illegible]	34.6	[illegible]	42.0	[illegible]	[illegible]	53.0	57.0		
	CUMULATIVE DEFICIENCY	15.0	38.0	68.0	102.6	140.6	182.6	228.6	277.6	330.6	387.6		19.38
TIDE (ASTRONOMICAL) RECORDINGS													
MILLIONS OF DATA POINTS	FUTURE DEMAND	[illegible]	13.9	[illegible]	15.3	16.1	16.9	17.7	18.6	[illegible]	20.5	166.1	1164.10
	CURRENT SUPPLY	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6		
	ANNUAL DEFICIENCY	1.6	[illegible]	[illegible]	[illegible]	[illegible]	5.3	6.1	[illegible]	[illegible]	8.9		
	CUMULATIVE DEFICIENCY	1.6	3.9	[illegible]	10.6	15.1	20.4	26.5	33.5	41.4	50.3		356.30
TOTAL TEN YEAR DEMAND FOR SELECTED PHYSICAL-CHEMICAL DATA (BILLIONS OF BCD CHARACTERS)													1.937
TOTAL TEN YEAR INCREASE IN DATA SUPPLY REQUIRED ABOVE EXISTING LEVELS (BILLIONS OF BCD CHARACTERS)													.757

*FY69 data volumes

NOTES:
1. SST: [illegible] BCD CHARACTERS FOR OBSERVATION.
2. BT AND XBT: [illegible] BCD CHARACTERS PER CHART.
3. STD: [illegible] BCD CHARACTERS PER RECORDING.
4. NANSEN CASTS: [illegible] BCD CHARACTERS PER CAST.
5. CURRENTS: 50 BCD CHARACTERS PER METER HOUR.
6. TIDES: [illegible] BCD CHARACTERS PER DATA POINT.

TABLE III-9 (Cont'd.)
COMPARISON OF DEMAND WITH SUPPLY FOR SELECTED DATA PARAMETERS

UNITS		71	72	73	74	75	76	77	78	79	80	TEN YEAR TOTALS	MILLIONS OF BCD CHARACTERS REQUIRED
GEOLOGICAL/GEOPHYSICAL MEASUREMENTS													
SOUNDINGS													
MILLIONS OF SOUNDINGS	FUTURE DEMAND	200	200	200	200	200	500	500	500	500	500	3,500	87,500
	CURRENT SUPPLY*	178	178	178	178	178	178	178	178	178	178		
	ANNUAL DEFICIENCY	22	22	22	22	22	322	322	322	322	322		
	CUMULATIVE DEFICIENCY	22	44	66	88	110	432	754	1076	1398	1720		43,000
MAGNETIC FIELD INTENSITY RECORDING**													
MILLIONS OF DATA POINTS	FUTURE DEMAND	8	20	60	60	60	100	100	100	100	100	708	17,500
	CURRENT SUPPLY*	6	6	6	6	6	6	6	6	6	6		
	ANNUAL DEFICIENCY	2	14	54	54	54	94	94	94	94	94		
	CUMULATIVE DEFICIENCY	2	16	70	124	178	272	366	460	554	648		16,200
GRAVITY FIELD INTENSITY RECORDINGS**													
THOUSANDS OF OBSERVATIONS	FUTURE DEMAND	570	570	570	570	570	770	770	770	770	770	6,700	167.5
	CURRENT SUPPLY*	540	540	540	540	540	540	540	540	540	540		
	ANNUAL DEFICIENCY	30	30	30	30	30	230	230	230	230	230		
	CUMULATIVE DEFICIENCY	30	60	90	120	150	380	610	840	1070	1300		32.5
TOTAL TEN YEAR DEMAND FOR SELECTED GEOLOGICAL/GEOPHYSICAL DATA (BILLIONS OF BCD CHARACTERS)													106
TOTAL TEN YEAR INCREASE IN SUPPLY REQUIRED ABOVE EXISTING LEVELS (BILLIONS OF BCD CHARACTERS)													60
SURFACE METEOROLOGICAL PARAMETERS***													
MILLIONS OF OBSERVATIONS	FUTURE DEMAND	3.38	4.19	4.46	4.64	4.89	5.04	5.18	5.35	5.41	5.68	48.22	2,073
	CURRENT SUPPLY*	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33		
	ANNUAL DEFICIENCY	2.05	2.86	3.13	3.31	3.56	3.71	3.85	4.02	4.08	4.35		
	CUMULATIVE DEFICIENCY	2.05	4.91	8.04	11.35	14.91	18.62	22.47	26.49	30.57	34.92		1,502

*FY69 data volumes.

**Does not include data collected by industry.

***Standard WMO code.

NOTES: 7. SOUNDINGS: 100 BINARY BITS PER SOUNDING = 25 BCD CHARACTERS.
8. MAGNETIC FIELD INTENSITY: 100 BINARY BITS PER DATA POINT = 25 BCD CHARACTERS.
9. GRAVITY FIELD INTENSITY. 100 BINARY BITS PER DATA POINT = 25 BCD CHARACTERS
10. SURFACE METEOROLOGICAL PARAMETERS: 43 BCD CHARACTERS PER OBSERVATION

computations are useful because they show the total increment of new data which must be collected and maintained during the decade and the augmentation of existing data collection, data input and data base maintenance which must be provided.

Table III-10 has been provided to show the increase in data input capability which is required at various data service facilities in order to accommodate increases in input data. The existing data input capability of selected facilities is indicated. This input rate is subtracted from the total data input required in the period FY 71-80 in order to determine the additional input capability which will be required of the facilities in the next decade. In all cases except one (Nansen casts), the data input capability must be increased substantially above existing levels. In no case will the quantity of data result in unprocessed backlogs if the data is in machine-processible form. Most geophysical data (magnetic field intensity and gravity field intensity), a large part of bathymetry, and current and tide data, will be in digital format. The largest potential digital data input is the NAVOCEANO soundings data. The 10-year input comprises 3.5 billion soundings (87.5 billion BCD characters). This amount of data is roughly equivalent to 4,400 reels of magnetic tape in 10 years, or between 1 and 2 reels of input per day. Although there will be a significant increase in the amount of geophysical and bathymetric data collected during the decade, most of this data will be in digital format because it will be acquired and preprocessed with the aid of shipboard computers. Therefore, it will be possible to absorb 1 to 2 reels of magnetic tape input data per day with contemporary computing equipment. Although this amount of machine processible input data can be easily absorbed, problems will arise due to the requirement for processing an enlarged data base and the concomitant need for an increase in data indexing.

The majority of the oceanographic data collected by scientists and meteorological observations obtained from ships will not be recorded in computer format. These

TABLE III-10
COMPARISON OF DATA SUPPLY REQUIREMENTS WITH DATA SERVICE FACILITY INPUT CAPABILITY

DATA TYPE	(1) EXISTING DATA SUPPLY CAPABILITY (FY 71-80) X10⁶	(2) ADDITIONAL DATA REQUIRED (FY 71-80) X10⁶	(3) TOTAL DATA REQUIRED (FY 71-80) X10⁶	(4) PERCENTAGE INCREASE IN DATA SUPPLY	(5) MAJOR DATA SERVICE FACILITY	(6) EXISTING INPUT CAPABILITY OF DATA SERVICE FACILITY (FY 71-80) X10⁶	(7) NEW DATA INPUT CAPABILITY REQUIRED (FY 71-80) X10⁶
[illegible]	[illegible]	10.06	20.26	99	NWRC	9.13[a]	11.13[j]
[illegible]	[illegible]	3.63	6.59	123	NODC	1.46[b]	5.13
[illegible]	[illegible]	.33	.78	73	NODC	0	.78
[illegible]	[illegible]	.05	.11	80	NODC	.73[c]	-
[illegible]	[illegible]	.39	.85	84	NODC	.15[d]	.70
[illegible]	[illegible]	[illegible]	167	43	C&GS	116[e]	51
[illegible]	[illegible]	1720	3500	97	NAVOCEANO C&GS	1760[f] 13	1727
[illegible]	[illegible]	648	708	1080	NAVOCEANO C&GS	60[g] 4	644
[illegible]	[illegible]	1.30	6.70	24	NAVOCEANO C&GS	4.7[h] .7	1.30
[illegible] PARAMETERS [illegible]	[illegible]	[illegible]	48.22	263	NWRC	15.10[i]	33.12

[a] [illegible] observations in 10 years.

[b] [illegible] per day [illegible] 365 [illegible] = 1.46 [illegible] and [illegible] profiles in 10 years.

[c] [illegible] per day X 365 [illegible] = .73 [illegible] casts in 10 years.

[d] [illegible] observations per quarter [illegible] = 1.8 X 10 current observations in 10 years.
(Assume 12 observations = 1 meter hour), 1.8 X 10 observations = .15 X 10^6 meter hours in 10 years.

[e] C&GS annual collection rate [illegible] = 116 X 10^6 tide recordings in 10 years.

[f] NAVOCEANO annual collection rate [illegible] = 1760 X 10^6 soundings in 10 years.
C&GS annual collection rate [illegible] = 13 X 10^6 soundings in 10 years.

[g] NAVOCEANO annual collection rate [illegible] = 60 X 10^6 data points in 10 years.
C&GS annual collection rate [illegible] = 4 X 10^6 data points in 10 years.

[h] NAVOCEANO annual collection rate [illegible] = 4.7 X 10^6 observations in 10 years.
C&GS annual collection rate [illegible] = .7 X 10^6 data points in 10 years.

[i] [illegible] = [illegible] purchased + [illegible] international exchange = 1.51 annual observations X 10 = 15.1 X 10^6 observations in 10 years.

[j] Column (3) - Column (6).

data are stored by NODC and NWRC, respectively. Increases in the amount of data transcription to magnetic tape and physical handling of data will be in direct proportion to the increase in input data volume at these facilities. For example, the increase in annual data volume of marine surface observations at NWRC is 3.3 million. If it is assumed that 1/3 of these inputs must be transcribed to magnetic tape at NWRC, 1,000,000 inputs per year must be transcribed daily. Thus, there will be a daily increase of 4,000 inputs which will require transcribing. The total daily input is equal to the current quantity of 2,000 observations plus 4,000 additional inputs. Although this is not an insignificant volume of input, it should not result in NWRC being inundated by new data.

Other problems could result from an increase in data volume due to changing requirements for quality control, editing, and format conversion due to the development of new sensors and the acquisition of data by buoys and satellites. The primary effect of these requirements is the need for software development rather than the need for an increase in input hardware processing speed.

In order to indicate the impact of increased data volumes on the size of data bases, Table III-11 has been constructed. It shows the size of existing data bases for the data and facilities which have been discussed. In all cases, a sizeable growth in data bases is indicated for the decade. Except for NAVOCEANO bathymetric data (6.38 billion characters by FY 80), the storage required for these data bases is not significant. The significant factor is the file-processing time which will be required to manage these bases unless the data is structured for quick access to those portions in great demand, and for slower access to those portions of the data base for which there is less frequent demand. Since requests are received on a daily basis, daily access to any part of the data base may be required. Daily serial processing of the FY 80 BT file at NODC, consisting of 627×10^6 characters, would be inefficient. Of greater significance is the impossibility of serially processing the NWRC FY 80 marine surface observation file, consisting of 3.5×10^9 characters, on a daily basis. Methods of file organization which could be applied to these data bases are discussed in the NODC and NWRC sections of the TDP (Volume Two).

TABLE III-11

IMPACT ON DATA BASES OF INCREASES IN DATA VOLUMES
FY 71-80

DATA TYPE	DATA SERVICE FACILITY	EXISTING DATA BASE[1] $X10^6$	NEW DATA[2] (FY 71-80) $X10^6$	TOTAL DATA BASE FY 80 $X10^6$	TOTAL NUMBER OF BCD CHARACTERS $X10^6$
SEA SURFACE TEMPERATURE OBSERVATIONS	NWRC	33.43[a]	20.26	53.69	170
SEA TEMPERATURE PROFILES	NODC	1.25	6.59	7.84	627
STD RECORDINGS	NODC	0	.78	.78	125
NANSEN CASTS	NODC	.59	.11	.70	112
CURRENT MEASUREMENTS (Observations)	NODC	3.00	10.20[d]	13.20	550
TIDE RECORDINGS (Data Points)	C&GS	745[b]	167	912	6,384
SOUNDINGS	NAVOCEANO C&GS	216 144[c]	3487 13	3703 157	96,500
MAGNETIC FIELD INTENSITY (Data Points)	NAVOCEANO	36	708	744	1,860
GRAVITY FIELD INTENSITY (Observations)	NAVOCEANO	.40	6.70	7.10	177.5
SURFACE METEROLOGICAL PARAMETERS (Observations)	NWRC	33.43	48.22	81.65	3511

[a] Not all surface observations contain SST; 33.43×10^6 is maximum figure.

[b] 8500 station years. 8.76×10^4 data points = 1 station year (10 data points per hour X 24 X 365). 8500 station years = 745×10^6 data points.

[c] 8500 smooth sheets X 17,000 soundings per smooth sheet = 144×10^6 soundings.

[d] 850,000 meter hours X 12 observations per meter hour = 10.2×10^6 observations.

NOTE: 1. Existing Data Base information obtained from Table III-2.
2. New Data information obtained from Table III-9.

IV. DELINEATION OF PRIORITY MARINE DATA AND PRODUCTS

ADEQUACY OF CURRENT MARINE DATA, PRODUCTS, AND SERVICE OPERATIONS

In view of the recent rapid acceleration in activity and interest in the marine area, it is not to be expected that the various needs for data, products, and services are being met to the satisfaction of the pertinent user communities. The agencies who have the mission of meeting these developing needs are well aware of the problems that exist, and of new problems which are developing, and in many instances these agencies have either initiated new programs or have developed plans whose implementacion will satisfy some of these current unfulfilled needs. Existing inadequacies may be a reflection of inadequate data collection (which includes inadequate sensors), limited data acquisition, limitations in the current state of the art (e.g., forecasting), delays in product preparation, failures to update processing and analysis methods, inadequate dissemination of products (or data), or limited accessibility of data and products because of security or proprietary classifications, or inadequate retrieval capability of data storage systems. Some of these inadequacies are summarized in Table IV-1 for some of the major forecasting and descriptive products.

A major problem area is geographic coverage. For forecasting products the distribution of observations is inadequate. For example, surface weather observations are acquired from ships, islands, coastal stations, towers, and several buoys. The ship observations are obtained from vessels with other primary activities; therefore, the observations are concentrated in the shipping lanes or other limited areas of marine activity. Synoptic data are available only occasionally for some large oceanic areas. The resulting inadequate coverage limits forecasting accuracy. The same problem exists for essentially all forecasting products. Geographic coverage for descriptive products is a different problem. For example, adequate bathymetric maps are

TABLE IV-1
INADEQUACIES OF SELECTED PRODUCTS

Product	Major Producers	Product Inadequacies	Remarks on Adequacy of Data Services
Sea Surface Temperature Chart	USCG BCF BSF&W NWSC	• Closer spaced contour intervals (at least 1°C) is required. • Greater coverage is required in tropical areas.	• Use of computer plotters for chart making is needed (BCF and BSF&W). • Reduction in delay of publication of charts at Government Printing Office is needed.
Thermal Structure Forecast	NWSC NAVOCEANO (ASWEPS)	• Forecasts are highly subjective. Forecasts are not always timely due to manual and subjective procedures used for some forecasts.	• Product inadequacy not related to inadequacies in data service other than the need for greater utilization of computers to improve timeliness.
Extended Weather Forecast	NMC NWSC	• Forecasts do not contain sufficient detail to periods of 5-10 days. • Lack of thermal structure, sea surface temperature, and snow and ice cover data on a regular basis. • Lack of data on turbulent transport, excess radiation in the troposphere and at the surface, and heat budget data. • Excessive computation time.	• Data collection requirements, including sea surface temperatures, snow and ice boundary data, albedo and cloud cover and ocean thermal profile need to be specified to collection agencies for collection in a format acceptable to prediction models. • Product inadequacy primarily due to difficulties inherent in the development of model, rather than inadequacies in data services.
Coastal Weather and Wave Forecast	ESSA-WB NWSC	• Forecasts need to be localized for specific operations (e.g., oil drilling operations).	• Earlier receipt of hemispheric weather analysis from NMC is needed. • Spacing of observation stations at closer intervals is needed. • Assignment of marine specialists to forecasting centers is needed.

TABLE IV-1 (CONT'D)
INADEQUACIES OF SELECTED PRODUCTS

Product	Major Producers	Product Inadequacies	Remarks on Adequacy of Data Services
Wave Height Forecast	NMC NWSC	• Forecasts should be transmitted to merchant ships. • Forecasts are not sufficiently localized to serve as input for coastal forecasting.	• Use of wind field computations in wave predictions may propagate inadequacies in wind forecasts into wave forecasts. • Transmission of forecasts seaward requires improvement. • Wave data from NMC should be included on primitive equation tapes achieved at NWRC.
Hemispheric Weather Chart	NMC NWSC	• Charts sometimes received too late at forecast centers to be completely useful for making local forecasts.	• Predicted values of previous cycle are used as substitute for observations which are lacking in next cycle. • Lack of adequate communications of observations on a global basis. • An increase in the number of upper air stations is needed. • Utilization of AMVER system to obtain more weather observations is needed. • Hemispheric weather charts are received 3 to 6 hours after synoptic chart time from NMC.
High Seas Weather Forecast	ESSA-WB NWSC	• Facsimile transmissions to merchant ships are sometimes distorted. • Synoptic observations are needed from sparse data areas.	• Additional marine forecasting specialists are needed.

TABLE IV-1 (CONT'D)
INADEQUACIES OF SELECTED PRODUCTS

Product	Major Producers	Product Inadequacies	Remarks on Adequacy of Data Services
Surf Forecast	ESSA-WB NWSC	• Forecasts are limited to Southern California Coast	• There is only one full time surf forecaster for Southern California
Tsunami Warning	CGS	• State of the art does not permit prediction of occurrence of Tsunamis, nor magnitude, from seismic disturbance.	
Tropical Cyclone Advisory	ESSA-WB NWSC	• Difficulty in predicting intensity and movement of cyclones. • Difficulty in predicting course and speed of cyclone. • Storm warnings are sometimes issued prematurely.	• Sea Surface temperature at 1° C over a 300 km grid is needed.
Storm Tide Advisory (Warning Bulletins and Statements)	ESSA-WB NWSC	• Forecasts are not sufficiently localized at specific beaches, harbors and marinas.	• Forecast areas are too broad (only 20 centers for U.S. Coastal areas). • Assignment of marine forecasting specialists is required. • Extension of use of numerical models (such as Atlantic City model) to other areas.

TABLE IV-1 (CONT'D)
INADEQUACIES OF SELECTED PRODUCTS

Product	Major Producers	Product Inadequacies	Remarks on Adequacy of Data Services
Bathymetric Map	C&GS USGS NAVOCEANO Lake Survey	• Less than 1/3 of U.S. continental shelf and less than 1/2 of world ocean mapped at useful scales.	• Present production rate will provide 5% of planned coverage per year for continental shelves and 2.5% of planned coverage per year for World Ocean. • Lack of digitizing of soundings for producing maps. • Increased use of automation for map production is needed (CGS).
Water Column Properties Atlas (e.g., ocean station atlas) and Thermocline Depth Chart	C&GS USCG-CGOU BCF NAVOCEANO Lake Survey	• Autumn and winter ocean station data lacking in large areas of N. Atlantic and N. Pacific (as much as 100,000 square miles). • Product required for the Great Lakes.	• Product inadequacies primarily due to lack of data collection rather than inadequacy of data services.
Nautical Chart	C&GS NAVOCEANO Lake Survey	• Worldwide coastline of scale of 1:75,000 or larger is less than 25%. • Only 30% of harbor charts considered adequate.	• Lack of digitization of soundings for producing charts. • Hand corrections to nautical charts results in delays in updating. ADP maintenance of changes (e.g., hazards to navigation) is needed. • There are new (and unfulfilled) requirements for chart coverage, content, and format resulting from technological changes, e.g., increased use of supertankers and submersibles, new navigation systems, and new port facility systems.
Climatological Atlas	NWRC NAVOCEANO Lake Survey	• Greater position accuracy (better than present .1° WMO code).	• Change in WMO code is needed.

TABLE IV-1 (CONT'D)
INADEQUACIES OF SELECTED PRODUCTS

Product	Major Producers	Product Inadequacies	Remarks on Adequacy of Data Services
		• Atlases needed for Great Lakes and continental shelf.	• Wave and swell data, sea surface temperatures and surface current data exist in many agencies. • Consolidation of data bases is needed.
Wave and Swell Chart	NWRC NAVOCEANO Lake Survey	• Wave observations are obtained visually and are highly inaccurate.	• Dependence on visual observations must be gradually reduced by increased installation of wave gages along U.S. Coastal areas and on observation vessels.
Geological and Geophysical Report	USGS NAVOCEANO CERC Lake Survey	• Little geographical coverage of offshore areas. • Master index of geologic samples and studies is required.	• Accelerated field survey program in offshore areas is needed. • New product required.
Ocean Engineering Report	None	• Standard publications not available.	• New product required.
Geological Map	USGS BCF CERC Lake Survey	• Moderate scale maps are needed for offshore oil and mining operations. • Bottom sediment charts not available for large areas (100,000 square miles of the North Atlantic).	• Inadequate due to unavailability of product at larger scales and for greater portions of World Ocean and offshore areas.
Magnetic Field Map	C&GS NAVOCEANO CERC	• Coverage at medium scales inadequate for offshore oil and mineral operation.	
Navigation Notice	NAVOCEANO C&GS USCG	• Delays of 2 to 8 weeks in publishing changes in weekly <u>Notice to Mariners</u>.	• Automated composition of notices and maintenance and retrieval of changes is required.

available for only about one-third of the U.S. continental shelves and less than one-half of the world's oceans. The maps which are adequate generally cover areas of greatest interest and activity; however, even some of these areas are insufficiently described.

Another major problem in data collection is the density of observations. For forecasting products more complete data are often required from specific areas in order to provide more localized forecasts. The inadequacy of some of the existing bathymetric maps is the result of insufficient density of soundings. This same problem applies to other descriptive products. Adequate data collection is fundamental to the production of products to meet the needs of the expanding user communities, and cost effective methods for obtaining more complete data are required.

The major inadequacy in the forecasting areas is the state of the art. This applies to all meteorological products and even more to oceanographic forecasts. The overall accuracy of weather forecasting has shown a gradual improvement with the development of numerical weather prediction methods, satellite products, and improvements in communications and processing techniques; however, continued and intensive research efforts in basic meteorology, including air-sea interaction processes, are required in order to make these tools more effective for both meteorologists and oceanographers. Oceanographic and fisheries forecasting requires even greater effort since current experience is quite limited.

A major problem in navigation products is the time delay in incorporating changes into charts and in publishing changes in the Notice to Mariners. This problem results from the use of manual methods in making these corrections. The use of automated methods to alleviate this problem is currently being investigated. Time delays in the preparation of other products are often the result of excessive delays in acquisition of the required sets of data, or of priority problems resulting from limited budgets.

As previously stated, essentially all of the data services involved in handling marine data and producing products require some degree of upgrading of processing, analysis, and dissemination methods. These problems are specific to each service operation, and changes are being continually effected by each of the agencies. These problems are a result of rapidly changing user demands. Specific recommendations are contained in other sections of this report.

DETERMINATION OF PRIORITY MARINE DATA AND PRODUCTS

METHODOLOGY EMPLOYED FOR SELECTION OF PRIORITY DATA PRODUCTS

The activities of the marine data user communities can be broadly defined as falling into two categories: (1) operational, and (2) research, development, and planning. Operational activities require. and utilize, data products with short time applicability (environmental forecasting products) as well as long life products (environmental description products). Research, development, and planning activities, on the other hand, require and utilize long life products. The role played by environmental forecasting products in these latter activities is negligible. Within the two categories of activities the several user communities have diverse requirements, and various existing data products are produced in response to these requirements. A few are highly specialized and are produced for a specific and limited user group (e.g., the west coast albacore fishery advisory); however most of the products have broad applicability and are used by several communities (e.g., coastal weather forecasts, bathymetric maps).

In the process of delineating those products for which increased future emphasis is recommended (priority products), it is necessary to consider (1) the relative importance of the product application to national objectives, (2) the importance of each product in each major area of application in which it is used, and (3) the degree to which each existing product satisfies the

needs inherent in each application. The selection of priority products was, therefore, based on an assessment of the criticality of the various products in their various applications to activities contributing to national objectives, and an assessment of the adequacy of the products to meet the user needs in these applications.

In order to determine relative priorities in terms of national objectives, all marine operational activities, exclusive of research, development, and planning, were assigned to nine broad, discrete areas. The current allocation of Federal funding in marine operations was distributed among these nine areas. Adjustments in the allocations were carried out, based on existing and projected changes in Federal marine interests. These operational areas and the priority indices are:

- Naval Operations (27)
- Environmental Forecasting (9)
- Environmental Description (22)
- Fisheries (18)
- Merchant Shipping (4)
- Marine Engineering Design (11)
- Industrial (5)
- Resources Management (3)
- Recreation (1)

For each data product all of the significant, distinct applications were defined. For example, thermal structure forecasts are utilized in antisubmarine warfare operations, fishing operations, and instrument engineering operations (Table IV-2); however, the importance of the forecasts to these applications varies. They are essential to ASW operations, have major importance in fishing operations and the operational activities in instrument design, and have a minor effect in instrument engineering in industrial operations. In those cases where the product is essential, the application

TABLE IV-2

PRODUCT PRIORITY DETERMINATION EXAMPLES (OPERATIONS)

		OPERATIONS																				SCORES	
		NAVAL OPERATIONS (27)*		ENVIRONMENTAL FORECASTING (9)		ENVIRONMENTAL DESCRIPTION (22)		FISHERIES (18)		MERCHANT SHIPPING (4)		MARINE ENGINEERING DESIGN (11)		INDUSTRIAL (5)		RESOURCE MANAGEMENT (3)		RECREATION (1)		CRITICALITY	UNFULFILLED NEEDS
PRODUCT	APPLICATIONS	IMP	UN	IMP	UN	IMP	UN	IMP	UN	IMP	UN	IMP	UN	IMP	UN	IMP	UN	IMP	UN		
THERMAL STRUCTURE FORECASTS	ASW	4	A3 D4																	171	273
	FISHING							2	A2												
	INSTRUMENT ENGINEERING											2	A1 G2	1	A1 G2						
OCEAN STATION ATLASES	ASW	4	I2	4	I2															351	418
	CHART MAKING					2	I2														
	SUBMERSIBLE OPERATIONS	4	I2 D2									2	D2 I1	2	D2 I1						
	FISHERY RESOURCE MANAGEMENT							2	D2 I1 T2							2					
	WATER QUALITY MANAGEMENT															2	D2 G2				
	INSTRUMENT ENGINEERING											1	D2 G2								

SCALES

CRITICALITY		UNFULFILLED NEED
Must Have	4	Primary
	3	Major
Major Effect	2	Moderate
Minor Effect	1	Minor

UNFULFILLED NEEDS DESIGNATORS

- A = Accuracy
- D = Density of Data Collection
- G = Geographic Coverage
- I = Data Detail in Product
- T = Timeliness

*Priority Index

within an operational areas was assigned a value of 4; if the product is of major importance but not essential, the assigned value was 2; and if the importance was minor, the assigned value was 1. To determine the overall "criticality" score for a given product, including all of its significant applications (uses), the product of each "importance" value and the priority index for the operational area were obtained, and the products summed. For thermal structure forecasts, the sum of these products totals 171, which is the criticality score for this product (Table IV-2).

Unfulfilled-needs values were also assigned to each application. Unfulfilled needs existed in various product applications in eight characteristics: product accuracy; product accessibility; density of data collection; frequency of production; breadth of geographic coverage; sufficiency of detail in the product; timeliness of production issue, end dissemination of the product; and volume of production of the product. Within the context of each application, values ranging from four to one were assigned for each unfulfilled need. For example, in Table IV-2 the application of thermal structure forecasts to ASW operations is seriously limited by inadequate density of data collection, and there is a major need for more accurate forecasts (improved forecasting methods) for use in ASW operations. Improved forecasting accuracy is of moderate importance in fishing applications, and is of minor importance in the two instrument engineering applications. For both of the instrument engineering applications, limitations of geographic coverage of the forecasts are of moderate importance. To obtain the unfulfilled-needs scores for each product in all of its applications, the sum of the products of the unfulfilled needs values and the priority indices for the operational areas were obtained. The unfulfilled-needs score for thermal structure forecasts, for example, is therefore 273 (Table IV-2).

The selection of environmental forecasting products for priority consideration was based on the criticality and unfulfilled-needs scores derived from the analysis of their applications in operational activities only. (Environmental

description products selection incorporated applications to research, development, and planning activities, and will be discussed later.) The ranking of the priority products is indicated in Table IV-3. The criterion for selection was that the product had both a high criticality score and a high unfulfilled-needs score. On this basis, those products which satisfy current and projected needs were not included in the list. Routing charts and revisions, Great Lakes water level predictions, and iceberg advisories were among the products not included.

Environmental description products were analyzed both in terms of applications to operational areas and applications to research, development, and planning activities. The derivation of the components of the scores resulting from operations applications is illustrated in Table IV-2. Ocean station atlases have use in ASW operations, chartmaking operations, submersible operations, fisheries resource management, water quality management, and instrument engineering. The criticality score for these applications is 351, while the unfulfilled needs score is 418.

The projected allocation of Federal funds for marine research, development, and planning fall into 13 categories:

- National security
- Research
- Surveying and mapping
- Marine exploration
- Marine observation technology
- Marine forecasting
- Fisheries development
- Seafood technology
- Transportation and commerce
- Marine engineering
- Development and conservation of the coastal zone
- Development of nonliving resources
- Health

The priority indices, based on the projected allocations are indicated in Table IV-4. Ocean station atlases have significant use applications in ASW planning, ocean current research, fisheries research, and water quality control planning. The criticality scores and unfulfilled-needs scores assigned to

TABLE IV-3

CRITICALITY AND UNFULFILLED NEEDS SCORES FOR PRIORITY DATA PRODUCTS

PRODUCT	CRITICALITY SCORE	CRITICALITY NORMALIZED	UNFULFILLED NEEDS SCORE	UNFULFILLED NEEDS NORMALIZED
FORECASTING PRODUCTS				
SEA SURFACE TEMPERATURE CHART*	185	.64	294	1.00
THERMAL STRUCTURE FORECAST	171	.59	273	.93
EXTENDED RANGE WEATHER FORECAST	195	.67	245	.83
COASTAL WEATHER AND WAVE FORECAST	151	.52	237	.81
WAVE HEIGHT FORECAST	291	1.00	230	.78
HEMISPHERIC WEATHER CHART	150	.52	211	.72
PRODUCTS OBTAINED FROM SATELLITE REMOTE SENSORS	85	.29	207	.70
HIGH SEAS WEATHER FORECAST	204	.70	182	.62
FISHERY PRODUCTS REPORT**	162	.56	180	.62
SURF FORECAST	142	.49	166	.56
SEA ICE FORECAST	118	.41	162	.55
TSUNAMI WARNING	132	.45	154	.52
TROPICAL CYCLONE ADVISORY	166	.57	147	.50
STORM SURGE ADVISORY	96	.33	142	.48
ESTUARINE FLUSHING PREDICTION	38	.13	132	.45
FISHERY ADVISORY & ABUNDANCE FORECAST	36	.12	36	.12
DOMESTIC ICE FORECAST	8	.03	8	.03
DESCRIPTIVE PRODUCTS				
BATHYMETRIC MAP	815	1.00	1261	1.00
WATER COLUMN PROPERTIES PRODUCTS	525	.64	548	.43
NAUTICAL CHART	479	.59	529	.42
CLIMATOLOGICAL ATLAS	281	.34	517	.41
WAVE AND SWELL CHART	281	.34	517	.41
THERMOCLINE DEPTH CHART	167	.20	456	.36
PILOT CHART	308	.38	380	.30
SURFACE CURRENT CHART	308	.38	380	.30
GEOLOGICAL AND GEOPHYSICAL REPORT	153	.19	372	.30
OCEAN ENGINEERING REPORT	131	.16	372	.30
GEOLOGICAL MAP	119	.15	361	.29
HYDROGRAPHIC SURVEY SHEET	227	.28	328	.26
FISHERY RESOURCE ATLAS	149	.18	298	.24
SPORTFISHING ATLAS	149	.18	298	.24
MAGNETIC FIELD MAP	120	.15	258	.20
GRAVITY FIELD MAP	120	.15	258	.20
SEA SURFACE TEMPERATURE ATLAS	206	.25	239	.19
ICE ATLAS	270	.33	200	.16
FISHERY STATISTICS REPORT	134	.16	111	.09
NAVIGATION NOTICE	271	.33	40	.03

*This product embodies the results of an SST forecast.

**Used to make short term forecasts of Fishery Market conditions.

TABLE IV-4

PRODUCT PRIORITY DETERMINATION EXAMPLE (RESEARCH, DEVELOPMENT AND PLANNING)

PRODUCT	APPLICATIONS	NATIONAL SECURITY (23)* IMP	NATIONAL SECURITY (23)* UN	RESEARCH (15) IMP	RESEARCH (15) UN	SURVEYING AND MAPPING (10)	MARINE EXPLORATION (10)	MARINE OBSERVATION TECHNOLOGY (3)	MARINE FORECASTING (5)	FISHERIES DEVELOPMENT (11)	SEA FOOD TECHNOLOGY (4)	TRANSPORTATION AND COMMERCE (3)	MARINE ENGINEERING (3)	DEVELOPMENT AND CONSERVATION, COASTAL ZONE (6) IMP	DEVELOPMENT AND CONSERVATION, COASTAL ZONE (6) UN	DEVELOPMENT, NON-LIVING RESOURCES (4) IMP	DEVELOPMENT, NON-LIVING RESOURCES (4) UN	HEALTH (3) IMP	HEALTH (3) UN	SCORFS: CRITICALITY	SCORFS: UNFULFILLED NEEDS
OCEAN STATION ATLASES	ASW PLANNING	4	I2																	174	118
	OCEAN CURRENT RESEARCH			2	I2																
	FISHERIES RESEARCH			2.	I2																
	WATER QUALITY CONTROL PLANNING													2	D2 G2	1		2			

*PRIORITY INDEX

COMBINED SCORES - CRITICALITY = 525 UNFULFILLED NEEDS = 548

those applications are indicated in the table. The criticality score for research, development, and planning activities is 174, and the unfulfilled-needs score is 118. These scores were combined with the scores derived from the operations applications analysis to provide a final criticality score of 525 and a final unfulfilled-needs score of 548. The scores for all of the priority descriptive products are indicated in Table IV-3.

In order to determine the sensitivity of the method of scoring to the priority index used (projected allocation of Federal funds), the analysis was repeated using equal priorities for each area of operations and each area of research, development, and planning. This procedure altered some of the specific rankings, and significantly changed the scores; however, there was no significant change in the grouping of priority versus other products. The important determinants of priority were, therefore, the total number of distinct applications of a product, the importance of product use in each application, and the inadequacies of the product for each application. The criticality values and unfulfilled-needs scores were either provided or reviewed by authorities in the respective areas of application prior to the final analysis. The results of the analysis were also reviewed and, as a result, several products were added to the priority lists for reasons independent of the factors considered in the analysis.

The data products considered in the priority analysis are those which are produced on a regular basis in response to existing user needs. Specialized products, such as reports of research results or other documents prepared for very limited audiences, were not considered. Some of these products may, of course, be of great importance; however, they do not significantly affect foreseeable data management problems. In a later section a series of new products are recommended. The production of these new products would be in response to growing and changing user requirements. Their implementation will significantly affect future data management systems.

DESCRIPTION OF PRIORITY PRODUCTS

Forecasting Products

Forecasting products are defined as either the end-product of a forecasting activity, e.g., wave height forecast, or as an item used in making a forecast, e.g., fishery product report used for forecasting market conditions. The important characteristic of forecasting products is that their value for forecasting applications decreases with time, whereas their value for historical analysis is maintained and may even increase with time.

Hemispheric Weather Charts (Analyses and Prognoses)

This group of products includes surface synoptic analyses, auxiliary analyses, surface prognoses, upper air prognoses, extended forecasts (three and five-day, and 30-day outlook), and nephanalyses. These products which cover the Northern Hemisphere, are produced by the National Meteorological Center (NMC) for civilian and military use, and by the Fleet Numerical Weather Central (FNWC) for military use. NMC issues 40 facsimile charts daily to provide guidance to Weather Bureau Offices with marine forecasting responsibilities. A major purpose of these charts is to provide forecasters with a broad view of weather patterns for use in predicting weather and sea state conditions; they are also useful for naval and merchant ship routing.

NMC produces hemispheric prognostic weather charts through use of primitive equation (PE) numerical prediction models. At the start of each processing cycle (two per day), all surface and upper air observation data received for a given synoptic chart time are used to compute future values of relative humidity, precipitation amount, pressure, temperature, wind velocity, pressure level height, and vertical velocity for each level at each grid point. These values are stored on the PE merged output tape and are the basis for generating digital plotter tapes used in producing wave height and long range forecasts. NMC currently makes long range forecasts using these tapes. These values are

also used to fill in data in areas where there are no observations for the next synoptic chart time. This procedure can cause forecast errors to be propagated throughout future weather and wave predictions. Increasing the number of upper air stations to one every 300 km in the tropics and one every 600 km elsewhere would improve the forecasts using the existing numerical models.

The preliminary operational processing cycle for hemispheric charts begins with the collection of hemispheric surface and upper air observations during a three-and-one-half hour period following obervation time. These observations serve as the base for constructing analyses of 13 levels in the atmosphere, from the surface to 30 km (10 mb). These analyses of pressure, geopotential temperature, humidity, and wind provide the initial conditions to compute the six-layer PE model. The model is currently calculated to 48 hours and provides forecasts of meteorological and limited oceanographic parameters at intervals of 6 or 12 hours. These PE products, some of them manually monitored and adjusted by professional meteorologists, are distributed by facsimile to local forecast offices and other domestic and international users. Since only 60 to 80 percent of the observations are received by the three-and-one-half hour starting time of the operational cycle, a final "cleanup" run is made once a day at 10 hours after observation time. Over 90 percent of the data are available for this operation.

Wave Height Forecasts

This group of products includes wind-wave prognoses, swell prognoses, and combined wave forecasts for 24-hour and 36-hour periods. They are issued in the form of areal charts for the North Atlantic and North Pacific Oceans, containing contour lines of forecast wave heights at three foot intervals and values of maximum wave heights centers. Twenty-four charts per day are transmitted, 10 to each Atlantic, Gulf of Mexico, and Pacific seaboard station, and four combined wave charts to the Gulf of Alaska stations. The NWSC produces wave charts on a hemispheric basis for use in Navy and MSTS ship routing.

These forecasts are essential for optimum ship routing and for the avoidance of high seas by naval and merchant vessels. They are also used as input for coastal wave and surf forecasting.

Wave forecasts are a new NMC product being provided to forecast centers from NMC via the National Facsimile Network. As an input for coastal wave and surf forecasting, tney are often not sufficiently localized; however, they provide a broad-scale picture of sea conditions to local forecasters.

Extended Range Weather Forecasts

These products consist of bulletins, charts, and outlooks predicting the average weather conditions and circulation patterns for two-day to six-day periods for both coastal and oceanic areas. Longer range weather outlooks are produced which project average monthly weather quotations and circulation patterns for the northern hemisphere.

Since most of the weather system which originate in oceanic areas will in time determine continental weather, accurate descriptions and predictions for the high seas and coastal regions will materially improve the accuracy of descriptions and predictions for inland areas.

FNWC is producing ten-day forecasts based on a historical file of digitized surface and 500-mb weather charts for the past 22 years. The research efforts in producing forecasts have met with some success. However, the effort has been hampered by the lack of ocean thermal structure analyses (through the thermocline), surface current data, and snow and ice cover data on a regular basis and in a format acceptable to the prediction models.

Coastal Weather and Wave Forecasts

These forecasts indicate surface weather and sea conditions and upper air conditions for periods up to 36 hours after the previous synoptic time for

all U.S. coastal areas out to 50 miles at sea. They are produced four times daily by 18 area forecast centers. Warnings are issued for expected hazardous conditions as required.

Coastal weather and wave forecasts are of major importance in the short-term planning of salvage operations and submersible vehicle operations. Adverse weather conditions can limit or prevent these activities and operations. Both commercial and sportfishing vessels require these forecasts for day-to-day planning and operations in order to maximize catch and avoid hazardous conditions. A common complaint from users is that forecasts are made for a large area and are not sufficiently localized to be of use for a specific oil drilling rig, amusement pier or marine coastal engineering operation.

High Seas Weather Forecasts

These forecasts indicate surface weather for periods up to 36 hours for oceanic areas extending from 50 miles offshore to limits defined by the World Meteorological Organization (WMO) International Convention. They are issued by three area forecast centers (and by Fleet Weather Centrals) four times daily. Bulletins contain forecasts and warnings.

These forecasts are utilized directly in navigation and routing of naval and merchant ships including sea-going tugboat operations. Since these forecasts provide a means of predicting sea state and fetch, they are also an essential input for surf condition forecasts.

Shipping companies state that these forecasts are not available in some locations, that the facsimile charts received are difficult to read because of distortion, and that there is not a close adherence to transmission schedules. Of the two commercial and five Navy radio stations which broadcast marine weather information for the Pacific Ocean and South China Sea, none transmits more than 300 miles seaward north of 8° south latitude. Facsimile transmissions

are made on a direct beam from San Francisco to Melbourne, Australia, and from Honolulu to Wake and Kwajelein Islands for use by Weather Bureau units at these locations. Forecasters state that their forecasts would improve if an increased number of equally spaced synoptic reports (300-500 miles) in their area of responsibility were available. They also reveal that hemispheric products from NMC are sometimes received after the beginning of their forecast cycle for the same synoptic period.

Storm Surge Advisories (Storm Tide Warning Bulletins)

These warnings are contained in bulletins describing a tidal surge expected as a result of storm conditions offshore. They are prepared for nine coastal areas, and are broadcast four times daily when surge conditions exist or are forecast for a given area.

Timely and accurate surge warnings are required in order to minimize property losses. Local statements on storm tides are issued by 20 Weather Bureau Offices along the U.S. coast; however, the forecasts are not sufficiently localized to predict conditions effectively at specific stretches of beach, individual harbors, marinas, and amusement piers. Forecasters are hampered by a lack of local tide data, adequate storm size and intensity data, and a quick and accurate technique for predicting surge.

Tropical Cyclone Advisories

These advisories are issued as bulletins reporting the location, direction and rate of movement, and wind velocities of cyclonic systems originating in tropical zones. The average annual occurrence of tropical cyclones affecting the U.S. area of forecasting responsibility is 44. Advisories are issued four times daily when appropriate, and bulletins are issued more frequently when necessary. On a global basis, the National Environmental Satellite Center (NESC) issued 521 satellite weather bulletins concerning detected tropical cyclones during 1967. Advisories for storms in the Western Pacific area are issued by the Navy and Air Force, who also utilize NESC advisories.

Complaints from some users of these advisories (particularly industrial operators along coastal areas) indicate that storm warnings are not always timely due to inaccuracies in path predictions. The resulting interference with normal or planned operations may be costly. There is a definite requirement to reduce overwarning.

Surf Forecasts

These products describe existing and expected surf heights and periods at selected beach areas. They include warnings of hazardous conditions such as unusually high surf, rip currents, and surges, and may include beach erosion information. Forecasts cover a period up to 36 hours. They are issued once daily for five beach areas in Southern California.

These predictions are of interest to surfers, swimmers and boaters. Presently, surf forecasts are provided for only selected areas along the Southern California coast. A need for a similar service has been expressed for areas with sandbar entrances to harbors along the entire West Coast.

Surf forecasters are presently limited by the lack of real-time monitoring of wave conditions in specific locations.

Tsunami Warnings

These warnings consist of bulletins which advise the public of the expected times of arrival of a seismic wave at various coastal locations. Normally, several sequential warnings are issued for each detected tsunami. In the past 11 years, 44 tsunamis have been detected. Predicted arrival times are within 2.5 percent of total travel time.

A present limitation is the difficulty in accurately predicting wave height and runup, which results in unnecessary evacuations.

Products Obtained from Satellite Remote Sensors

This group of products consists of charts indicating snow and ice boundaries and mean brightness, analog pictures, and digitized mapped mosaics. There are 72 computer products, 13 manual products, and 12 photo products produced per day. There were also 521 satellite storm advisories and 869 miscellaneous satellite bulletins issued in 1967. The spot resolution for existing products is four nautical miles, with mean brightness values ranging from 0 to 15 (or 63 prior to data compression). Products planned for the future include sea surface temperature charts, charts indicating mean humidity values for NMC grid points, and charts depicting the vertical temperature structure of the atmosphere. The data from which these products are or will be derived are collected through the use of satellite infrared sensors and vidicon cameras.

The satellite photo products make possible the accurate location of large scale weather systems on a global scale, and they have proved to be of particular value in identifying, locating, and tracking severe storms, including tropical cyclones. They are the only source for large scale snow and ice cover data. The planned sea surface temperature charts will be used in ASW predictions, in the location of fish, and in numerical weather prediction operations.

Forecasters have noted a lack of analyzed photos and products in a format for input to a digital processing system. For example, data on snow and ice cover are in chart rather than digital form.

Sea Surface Temperature Charts

These charts indicate the horizontal distribution of sea surface termperatures. They are produced on a daily, weekly, bimonthly, and monthly basis and cover regions ranging from local operating and fishing areas to total global coverage. They are prepared from data obtained from ship observations and by airborne

radiation thermometers. These charts are used for both forecasting and in historical data studies. An example of the former is the daily computer plots of SST charts produced by FNWC for both naval forecasting and fishery advisory applications. These charts are essential in ASW operations. They are also of importance to fishery scientists, commercial fishing fleets, and others interested in the thermal characteristics of the ocean. Present needs include broader geographical coverage, especially in the southern hemisphere; more closely spaced contour intervals (at least 1°C or F) are required for historical SST charts; and more timely preparation and distribution of the charts. At the present time, with the exception of the daily charts used for forecasting, time lags between observation and final dissemination of the products may be as long as a month.

Sea Ice Forecasts

These products are issued as large-scale charts which cover specific areas (e.g., Baffin Bay, north coast of Alaska). They indicate the nature, extent, and concentration of sea ice cover by means of symbols and patterns on the chart. Iceberg concentrations and distributions may also be indicated. Such forecasts are transmitted by radio teletype and facsimile to naval and other vessels operating in ice areas.

Sea ice forecasts are an essential product for ship routing and operations planning for merchant shipping in areas where ports and shipping lanes are subject to icing. They are also essential in the planning of naval logistics operations in support of polar stations and bases, and in the planning of naval submarine operations in polar waters. Industrial operations are increasingly concerned with sea ice in view of the growing promise of economic return through development of mineral and petroleum reserves in the Arctic.

Domestic Ice Forecasts

Forecasts of ice breakup dates for the Great Lakes are produced by the ESSA Weather Bureau. These forecasts are based on the correlation of the historical

breakup dates and number of freezing days for the month of February. Forecasts are made in early March for ice breakup in April.

Forecasts for the St. Lawrence Seaway are provided by the Canadian Government. Predictions for the Hudson River and the Delaware Ship Canal are provided as required; forecasts are not made on a regular basis.

The effectiveness of merchant shipping operations and routing in the Great Lakes and other inland waterways is directly dependent on the timeliness and accuracy of these forecasts. Ice forecasts are also important to residents and municipalities in the Great Lakes area in providing for public safety and in planning recreational activities.

Present forecasts have about a two-week uncertainty, whereas accuracy within one day is desired. Five-day warning of port reclosing and daily ice survey bulletins following the initial opening of ports and during the final days before freeze-up are needed. Ice survey bulletins should contain ice coverage, ice thickness and ice type data.

Thermal Structure Forecasts

These daily forecasts consist of charts which depict the observed and predicted vertical thermal structure, including thermocline depth, thermocline gradient, and the location of ocean fronts.

These forecasts are an essential input to ASW operations. Recent research indicates that these forecasts may also be important in increasing the efficiency of tuna fishing operations. More localized forecasting, such as for the Gulf of Maine, are desired by these users. Presently, the only source for these predictions is the Naval Weather Service Command.

Estuarine Flushing Predictions

This product is currently being provided on a one year experimental basis for the Penobscot River and Bay Estuary in Maine. Forecasts are issued on the third and eighteenth day of each month, of the rate at which possible pollutants will pass through the estuary from various points of origin.

During summer periods, when the rate of flow through the estuary is at a minimum, the residence time of pollutants will increase and deleterious effects on water quality may result. These predictions are therefore of major importance to those agencies responsible for water quality control, and they directly affect the operations of those industries and municipal waste treatment plants discharging wastes into the river and estuary.

Fishery Products Reports

These reports consist of daily, weekly, monthly, and annual tabulations of catch, processing, distribution, and market data. The data include information concerning landings, receipts, supplies, prices, imports, distribution of fish and fish products in local areas, market conditions, and fishery developments in the U. S. and foreign countries. During 1966, there were a total of 1,770 daily reports, 5 complete annual reports, 2 preliminary annual reports, and 6 supplemental reports published. These reports are utilized principally by the processing and distributing segments of the fishing community as inputs for forecasting future market conditions and in day-to-day planning and operations.

At the present time the fishery products reports are not being integrated with other pertinent fishery information such as movements of the fishing fleet, success of their catching activities, and long term market trends. As important need exists for graphical displays of current catch, prices in relation to histories, and projected trends of these data.

Fishery Advisories

This product is currently limited to a special service for the west coast commercial albacore fishing fleet. It consists of a daily information service broadcast to the fishing fleet, and includes information pertaining to fishing activity and catch data, sea surface temperature conditions, fishing prospects, weather and sea state forecasts, and dockside prices. In addition to the daily advisories, some 14,000 to 20,000 synoptic marine observations are processed and used to prepare sea surface temperature charts which are distributed to the fishing community on a bimonthly basis during the fishing season. The broadcast advisories are used to advantage by both sport and commercial fishermen for planning fishery strategy. There is a need for similar advisory services tailored to the needs of other major U. S. fisheries. There is also a need for the integration of daily and long term fishery statistics into the advisory service; catch data is currently lacking on the sea surface temperature charts. Faster dissemination of these products is also needed. The present service is hampered by lack of environmental and fishing conditions data from the fishery fleet.

Fishery Abundance Forecasts

These are annual forecasts of the sizes of the harvestable populations of various species. Examples are of the forecasts of haddock and sea scallops on the New England banks, and of the spawning runs of salmon into some of the rivers of the Pacific Northwest. Development and perfection of these forecasts are important for (1) planning by the fishing industry and the seafood processing industry, and (2) for those who negotiate catch quotas with foreign nations whose fishermen share with ours in harvesting the same marine food resources.

Descriptive Products

A characteristic of descriptive products is that they contain historical data. Their value does not decrease with time; in fact, their value may increase with the passage of time.

Marine Historical Environmental Products

These products consist of atlases, charts, and tables which present historical environmental data. In general, these products are produced at scales of 1:10,000,000 to 1:50,000,000. These scales are adequate for deep ocean applications but scales of 1:250,000 to 1:1,000,000 are needed for continental shelf areas. The historical data are summarized for 5° latitude x 5° of longitude (up to 90,000 square nautical miles) and 1° x 1° (up to 3,600 square nautical miles): continental shelf data should be summarized at a spacing of 0.5° x 0.5° (up to 900 square nautical miles).

Climatological Atlases. Marine climatological atlases contain climatic data on a monthly basis, including surface wind roses (wind speed and direction frequencies), storm track means and distributions, sea level pressure, air temperature, sea temperature, precipitation, visibility, clouds, air-sea temperature differences and dew point.

Increased detail in the continental shelf and Great Lakes area is needed for vessel operations, outfall design, offshore oil and gas platform design, planning mining operations, and environmental prediction.

Wave and Swell Charts. These charts indicate monthly percent frequency of seas greater than 5, 8, 12, and 20 feet; monthly swell height, direction,

and constancy; seasonal persistence, wave period-height and wave period-direction; and seasonal percent frequency of seas requiring speed reduction. Worldwide small scale coverage is available.

Wave and swell height, period and direction observations should have at least ± 5 percent accuracy. Over 99 percent of the wave and swell data currently obtained are based on visual observations from forward-moving, pitching, and rolling platforms. The accuracy of such observations depend on the skill and experience of the observer, and will rarely approach ± 5 percent accuracy.

Sea Surface Temperature Atlases and Charts. These atlases consist of maps with monthly average sea surface temperatures. Standard isothermal intervals are 5°F and 10°F. Available products provide worldwide coverage in small scale maps, and selected coastal and oceanic coverage in more detailed maps.

Sea surface temperature charts are adequate for planning vessel operations, search and rescue operations, and recreational planning and activities. For long range forecasting and hurricane forecasting, 1°F isotherms, larger scale, and more frequent charts (e.g., weekly) are needed. One of the objectives of the Barbados Meteorological and Oceanographic Experiment (BOMEX) and similar air-sea interaction studies is to identify these requirements. For fish locating and fisheries research, 1° to 2°F isotherms, 1:100,000 to 1:1,000,000 scales, and bimonthly or weekly charts are needed for all the established fishery areas.

Surface Current Charts. Surface current charts indicate monthly mean direction and speed of surface currents and may also include mean frequencies of direction and speed of currents (i.e., current roses).

For utilization in ship operations planning, navigation, search and rescue planning and operations, and fish locating, an increase in detail for the

continental shelf area is needed. An additional unfulfilled need is for increased accuracy. Over 98 percent of the surface current data consists of set and drift observations made by Navy and merchant ships. These observations reflect the average surface current over a distance of 50 to 400 miles and have a highly variable accuracy because of variations in navigation accuracy, helmsmanship, and frequency of course changes.

Ice Atlases. This product consists of maps indicating the monthly average and extreme of ice coverage, thickness and type. Also included are the mean and range of ice freezeup and breakup dates.

Worldwide coverage is available only at small scales. Larger scales and increased geographic coverage, especially for continental shelf areas and the Great Lakes, are needed for planning ship operations and ASW operations, environmental predictions, offshore oil operations, offshore and shoreline structure design, and vessel navigation.

Water Column Properties Data Products. This product group includes ocean station atlases and plots, thermocline depth charts, sound velocity atlases and sonar range charts and plots. Ocean station data consisting of depth, pressure, temperature, salinity, density and oxygen content are the basis for all water column properties data products. Ocean station data are presented as graphs (a plotting of mean seasonal or monthly values at standard depths) for regions of similar water column characteristics. Vertical sections and horizontal sections (i.e., showing contours) are provided for 5° x 5° or 1° x 1° areas.

Thermocline depth charts are charts which contain contour lines indicating the mean depth of the thermocline by month or by season. Sound velocity atlases contain graphs of the velocity of sound for various depths, averaged over ocean regions of similar water column characteristics, for 5° x 5° areas, or 1° x 1° areas. They depict annual, seasonal or monthly conditions. The

more detailed sound velocity atlases are classified. Sonar range atlases indicate the performance capabilities of selected sonar equipment.

The average availability of autumn and winter ocean station data is less than one-fourth of the spring and summer data. In some areas (as large as 100,000 square miles in the North Atlantic) no unclassified winter ocean station data are available. A similar situation prevails for the North Pacific. The density of stations is even less in the South Atlantic, South Pacific and Indian Oceans.

Because of the lack of density of ocean station observations, these products are inadequate for such applications as ASW, fish locating, water pollution control monitoring, and the determination of velocity corrections for soundings. In addition, these products are only available for deep ocean areas; equivalent products are required for the continental shelves and the Great Lakes.

Pilot Charts. Monthly pilot charts are prepared for all oceanic areas. They indicate: average currents and prevailing winds; percentage of gales, calms and fogs; average air and water temperatures; average atmospheric pressures; limits of drift of field ice and icebergs; magnetic variations; and recommended routes. A similar product is not available for the continental shelf areas or the Great Lakes.

Marine Topographic Maps. Marine topographic maps include bathymetric maps and charts, and hydrographic survey sheets.

Bathymetric Maps and Charts. These maps and charts indicate the bottom topography with depth contours and depth values for peaks and deeps. Scales range from 1:50,000,000 to 1:5,000 and contour intervals from 1,000 fathoms to 1 fathom. The largest available scale with systematic coverage of the continental shelves is 1:250,000 with contour intervals of 10 meters to 200 meters depth, and 50 meters for depths below 200 meters. Depths which are corrected for sound velocity variations are used in bathymetric maps, while uncorrected depths are used in bathymetric charts.

About 90 percent of the North Atlantic and 80 percent of the North Pacific are covered by bathymetric charts ranging from 6° latitude by 10° longitude near the equator to 3-1/2° latitude by 15° longitude at 75° N. The South Atlantic Ocean, South Pacific Ocean, Indian Ocean, Arctic Ocean, and Antarctic Sea are not yet covered by this series. Worldwide coverage is available with the General Bathymetric Chart of the Oceans at scales of 1:10,000,000 at the equator and 1:3,100,000 at 75° latitude. A scale of 1:10,000,000 (1 nautical mile = 0.0073 inches) is inadequate for most applications.

All bathymetric maps and bathymetric charts are based on soundings shown on existing inventories of systematic survey data. The survey data are generally of high accuracy. Where there is no existing systematic survey coverage, random trackline data must be used. These random tracks have highly variable control accuracy. A star fix may be obtained infrequently along some tracks, while in other cases tracks may reflect nearly hourly satellite fixes. Some depth measurements are obtained from poorly adjusted fathometers recording on a scale of 200 fathoms per inch; while others are from fathometers maintained in continuous optimum adjustment, recording on a scale of 20 fathoms per inch. These "random" ship tracks, when collected, do not meet survey line spacing requirements. For a contour position accuracy of ± 1/16 inch, the survey line spacing should be 1/8 inch on the bathymetric map (e.g., 20-mile line spacing is needed for maps with a scale of 1:10,000,000 and 1/2-mile line spacing for maps with a scale of 1:250,000). Bathymetric maps at a scale of 1:1,000,000 (1 nautical mile = 0.073 inch) are available for the U.S. continental shelves (except Alaskan waters). Bathymetric maps at a scale of 1:250,000 are available for only 30 percent of the U.S. continental shelf. Great Lakes bathymetric map coverage is limited to one chart at a scale of 1:1,500,000.

A scale of 1:250,000 (1 inch = 4 statute miles) is needed for tsunami forecasting and fishery research. A scale of 1:62,500 is needed for waste disposal management, estuarine flushing forecasting, and offshore oil and mining operations, surf forecasting, submersible operations and salvage operations.

Navigational Products

Nautical Charts. Nautical charts show representative and/or critical soundings, selected bottom contours, aids to navigation, shoreline, landmarks, dangers to navigation, selected topographic features and contours, selected features (shore and offshore structures; cities and roads; railroads, buildings, churches and airports), isogonic lines, compass roses, sites of local magnetic disturbances, special areas (anchorage areas, seaplane areas, cable areas, etc.), the location of breakers, courses and ranges, and selected triangulation stations; and natural features (marsh areas, mangrove areas, cypress areas, bluffs, cliffs, sand beaches, and sand dunes, etc.); and lines of electronic aids to navigation (e.g., Loran "A" lines). Military installations generally are not shown, although many features (particularly radar domes) are prominent and are very useful aids to navigation. Objects of present military importance are charted only with the consent of military authorities.

Sailing charts are nautical charts at a scale of 1:600,000 or smaller. They are used for offshore sailing between distant coastal ports. They show offshore soundings and the most important lights, outer buoys, and natural landmarks which are visible at considerable distances. General charts of the coasts are nautical charts at scales from 1:100,000 to 1:600,000. They are designed for coastal navigation when a vessel's course is well offshore but while her position can be fixed by landmarks, lights, buoys, and characteristic soundings. Coastal charts are nautical charts at scales from 1:50,000 to 1:100,000. They are intended for close coastal navigation inside outlying reefs and shoals, for use in entering bays and harbors of considerable size, and for navigating the larger inland waterways. Harbor charts are nautical charts at scales larger than 1:50,000; the scale depends on the size and importance of the harbor and the number and kinds of dangers existing. These charts are intended for navigation in harbors and smaller waterways, and for anchorage. Small craft charts are nautical charts at scales of 1:80,000 and larger which are designed for easy reference and plotting in the limited space

available aboard small craft. They emphasize small-craft detail, including large scale inserts of small boat harbors; tide, current and weather data, whistle signals, marina facilities, anchorages, courses and distances.

Worldwide coastline coverage of nautical charts of 1:75,000 or larger is les than 25 percent. Coastline coverage at scales of 1:75,000 to 1:600,000 is 80 percent. Only for scales of 1:600,000 and smaller is worldwide coverage complete. Of the approximately 2,500 harbor charts needed worldwide, an estimated 30 percent are considered acceptable (fair or better) for use, 55 percent need revision and 15 percent are nonexistent.

The publishing frequency of nautical charts by C&GS varies from every three months (New York Harbor chart) to every four years (remote portions of Alaska). Some special nautical charts and some small scale charts are published even less frequently. NAVOCEANO charts are published at irregular intervals depending on stock levels and the number of corrections. A new edition is prepared when corrections are too numerous or too extensive to be reported in the weekly Notice to Mariners.

Nautical charts are dated for corrections added. A new edition obsoletes all previous printings. Corrected (new) prints and reprints include all changes published to the print date in the Notice to Mariners since the preceding issue of the chart. The date of the last Notice to Mariners used is indicated on the chart. Small craft charts are issued as new editions annually. The delays which occur in weekly Notice to Mariners are indicated in the discussion of Navigation Notices.

These dates give the user a false impression of timeliness of the data presented on the nautical chart. The date indicates the latest date used. The ages of the source of data are not indicated. For example, the most recent hydrographic surveys available for use in compiling some nautical charts were made in the nineteenth century.

Because of the various scales and because of the need for navigation continuity, nautical charts overlap. One change may affect as many as six charts and a harbor may be shown on up to four charts of various scales. This overlap or duplicate coverage has led to omission or generalization of detail on the smaller scale charts. Also, the Notice to Mariners is presently intended for application to larger scale charts and hand corrections are often not applied to the smaller scale charts.

The result of this complicated chart correction policy is that most users often have a misunderstanding of, or are confused or ignorant about, the inadequacies of nautical charts. Ninety-nine percent (8,300,000 of 8,350,000) of the vessels operating in U.S. waters are small pleasure boats and yachts. Of the operators of these vessels, only a few (mostly U.S. Power Squadron and U.S. Coast Guard Auxiliary members) have any knowledge of this chart correction policy or the limitations it places on the usefulness of nautical charts. There is a need for user education and for simplification of the chart correction policy.

Navigation Notices. Navigation notices consist of radio broadcasts, issues of Local Notice to Mariners and Daily Memorandums. Radio broadcasts include local or regional information of importance to the safety of vessels at sea. This includes the position of ice, icebergs, and derelicts, and inadequacy and changes in aids to navigation. The information is broadcast on receipt and repeated in scheduled broadcasts. Issues of Local Notice to Mariners and Daily Memorandum for local and regional areas are published as required, usually daily. They include changes in aids to navigation, reports of channel conditions, obstructions, dangers to navigation, the danger areas and reports of ice, icebergs and derelicts. Weekly Notice to Mariners is a compilation of navigation notices and is the authoritive source for all changes to nautical charts, light lists, sailing directions, coast pilots and other publications intended for use in navigation.

The delay time, from a radio broadcast or publication of an article in the Local Notice to Mariners and the Daily Memorandum, until the publication of

the broadcast or article in the weekly Notice to Mariners is four to eight weeks. For changes from foreign sources, the delay time from the occurrence to publication in the weekly Notice to Mariners has been as long as one year; however, such an extensive delay is rare.

It is possible that long periods can occur during which a United States chart of a foreign area cannot be corrected for changes. When a new edition of a foreign chart is issued, no notices are prepared by the foreign country. United States charts covering the same area are made obsolete by the new edition until it is inspected for changes by the U.S. charting agency and either Notice to Mariners articles are prepared and published or a new edition of the U.S. chart is prepared and published.

Any delay in the dissemination of navigation warnings constitutes a major hazard to safety of life and property.

Temporary deficiencies in aids to navigation are not published in the weekly Notice to Mariners when it is known that the defects will be corrected promptly. Also, the weekly Notice to Mariners states: "The heavy black type designation of charts to be corrected before using is an advisory service only and in no way relieves users of the responsibility for correcting all reference charts before they are used for navigation." These statements about temporary deficiencies and the heavy black type confuse the user.

Ocean Engineering Reports

An ocean engineering report should contain concise summaries of a wide variety of proven engineering information, and include tables of useful formulae, coefficients, etc. Information which should be included exists in a large number of diverse and limited-purpose engineering reports prepared by Federal agencies, private contractors, and educational institutions. This information should include data on physical properties and

performance histories (e.g., corrosion and fouling) of ocean engineering materials. Environmental design criteria information would include average, and 25-year, 50-year, and 100-year storm maxima for wave heights and period, wind speeds and directions, and storm surges; tsunami frequencies and runup data; average and extremes for pH, salinity, temperature, and ice cover areas and thickness; and long onshore currents and sediment transport information.

These reports would receive widespread usage in all areas of marine engineering planning and design, including offshore oil and mineral operations, outfall design, instrument development, marine exploration planning, and the design of harbor and other shore facilities. The pertinent engineering data must be obtained from a number of diverse and specialized reports and publications. Since some of these data are obtained for limited purposes there may be only original file copies; therefore, the collection of data for use in the reports may be somewhat difficult.

Geological and Geophysical Products

Priority products in this category are the various geological, geophysical, geochemical and hydrologic reports and map series which treat the deep oceans, the continental sheif areas, and the coastal and nearshore zone. These products are generated by at least twelve different organizations in four Federal agencies; the U.S. Geological Survey has the broadest program, followed by the Environmental Science Services Administration. Subject matter covered ranges from studies of potential mineral resources to foundation and related engineering geological reports, to charts of total magnetic and gravity field intensity, to basic research studies on a host of geological, geophysical, geochemical, and hydrologic topics.

Although oil companies routinely carry out detailed, proprietary offshore geophysical exploration and mapping programs, Federal Government preparation of regional reconnaissance (1:1,000,000) and intermediate scale (1:100,000 to

1:250,000) geological and geophysical maps (particularly of previous unexplored areas) of the continental shelf would be useful to offshore oil and mining companies.

Geological and Geophysical Reports. Geological and geophysical reports are the basic information products in this category and are generally accompanied by one or more maps, charts, and cross-sections, as well as a series of tables illustrating representative observational data. Such reports normally are regional to topical interpretative syntheses of all available data. Although some are research oriented, many emphasize such applied topics as offshore mineral resources, seafloor foundation characteristics, regional geology, and potential geological hazards.

Area of coverage of a report or map typically varies with the subject. The coastal zone and nearshore areas have sporadic coverage by such reports, the U.S. continental shelf areas are covered by less than 20 such reports, and the deep oceans have virtually no regional coverage and only a few topical reports.

Magnetic Field Maps. These maps indicate contours of the magnetic variation, total magnetic intensity, horizontal magnetic intensity, magnetic inclination (dip), annual rate of change of magnetic variation and total magnetic intensity anomaly. Worldwide coverage is available at scale of 1:39,000,000 and 1:12,233,000 at the Equator (Polar charts are at 1:10,000,000 at 71° latitude). United States coverage is available at 1:5,000,000. Coverage at scales larger than 1:5,000,000 is available only for selected areas. A very small percentage of the larger scale maps are classified.

The present coverage and scale are adequate for airplane and ship use in correcting for magnetic variation. However, the coverage at medium scales is inadequate for offshore oil and mineral exploration planning and operations. Nonsubmarine contact charts (classified) indicate the location of magnetic

anomalies and known wrecks. The precise location and magnitude of local magnetic anomalies is needed in these charts for ASW operations.

Gravity Field Maps. These maps indicate contours of the gravity field, gravity anomaly and deflection of the vertical. The gravity anomaly is the difference between the observed gravity and the theoretical gravity values based on a hypothetical earth of uniform density corresponding to the envelope of sea level. The gravity anomaly usually is either free air anomaly, corrected at sea level, or the Bouguer (density) anomaly, corrected to sea level and for the effect of the density of the underlying rocks. The gradient of the free air anomaly determines the deflection of the vertical.

The only unclassified gravity field and gravity anomaly maps available are the results from a few scientific studies (e.g., Upper Mantle Project) and for three gravity ranges. Nearly all gravity survey data and gravity data products are classified.

Geological Maps. This group of products includes maps and charts which indicate the surface and subsurface geological features of the sea floor: specifically the composition, thickness, and extent of sediment cover (bottom sediment charts); the stratigraphic and structural relations of the bedrock, geologic cross sections and generalized submarine gradients; and seismic regions, earthquake sites, volcano sites, and typical seismic reflection profiles.

Moderate scale geological maps (especially bottom sediment charts) are needed for offshore oil and mining survey planning and operations. Bottom sediment charts are used in ASW planning and operations for determining the bottom reflection and acoustic energy loss of underwater sound due to bottom characteristics. Knowledge of the composition (particularly calcium carbonate content), porosity, average diameter, degree of cementation (rigidity), and temperature of the bottom sediments is needed for the design of ocean bottom structures. Bottom sediment charts are also useful in bottom fishing planning and operations, skin diving and anchoring.

Worldwide coverage of bottom sediments charts is available at small scales (1:40,000,000). Even at this scale, data coverage is inadequate. For example, areas of the North Atlantic as large as 100,000 square miles are not represented by even one usable sample analysis. Data coverage for the North Pacific is similar; for the other oceans it is much more sparse. Coverage at larger scales is available only for selected areas. However, bottom characteristics for selected points are given on nautical charts.

Biological (Fishery) Products

Fishery Statistics Reports. These reports include monthly and annual tabulations of fisheries data, and an annual statistical digest of these data. Information contained in the reports may pertain to all fisheries in a State or region, including shell fish, or to a single fishery of major importance. The data tabulated include number of fishermen, vessels, and boats; fishing gear used; the volume and value of the catch; the production of fishery commodities; freezing and cold storage holdings; and processing employment figures. Specialized data may be included for specific fisheries, for example, catch/effort data or frequency distribution of length. Fishery statistics reports are utilized by the fishing industry in the planning and operations of fishing, processing, and distribution. They also provide Federal and State fishery agencies with information necessary for fisheries management.

There are currently no fishery statistical reports on the involvement of U.S. companies in international fish production, nor are there reports on the relative costs of fish production, processing or marketing for foreign countries competing in this lucrative market. Without statistical reports containing this information on these factors, it is virtually impossible to assess the economic value of world fishery resources and to formulate U.S. fishing policy regarding the development of these resources. There is a serious lack of timeliness and completeness of the present U.S. fishery statistical reports. Monthly reports on State fisheries are rarely published earlier than four months

after the month in which they were gathered. Summary statistics for these landings are not available until well after the end of the year. Additionally, the Fisheries Statistics of the United States is currently lagging two years behind in publication.

Present U.S. fishery statistical reports currently do not report such items as incomes derived from fishing, costs to investments in vessel operations, costs of obtaining capital, returns on investment, etc. Without these reports no evaluation of the economic status of our domestic fisheries and their relation to other aspects of our economy can be made. Fishery statistics reports also are needed to provide the basis for development of Federal and State policy regarding the fishing industry.

At the present time only three States--California, Oregon, and Washington--have a reporting system for sportfishing statistics. California collects data from sportfishing party boats on all species caught, while Oregon and Washington collect data only from salmon sportfishermen. Without adequate data on sportfishing it is impossible to assess the distribution of catch between commercial and sportfishermen. This problem becomes acute when the fishery involved is one that is being overfished, as the division of catch becomes a serious political issue between commercial and sportfishing representatives.

Fishery Resource Atlases. This group of products includes charts depicting annual and seasonal distributions of species of fishes, mollusks, and crustaceans of importance to the fishing industry. They also depict seasonal movements, egg and larvae distribution, and plankton and nutrient distributions.

These products are produced and utilized primarily by fishery scientists, and occasionally by fishery resources managers. In general the fisherman or processor is either unaware of their existence or uninformed as to how they might be useful to him. At the present time no resource atlas exists that has been keyed to industrial fishing needs.

Sportfishing Atlases. These products include species and fishing grounds distribution maps, seasonal movement charts, etc., similar to those provided in the fishery resources atlases. This information is supplemented by the addition of items of specific interest to the sportfisherman, such as boating facilities, supplies, and services.

These products are produced for, and utilized almost exclusively by, the knowledgeable recreational fisherman and sportfishing research agencies. There is a need for wider dissemination of these atlases to the public and the occasional sportfisherman. At the present time the existence of these atlases is not generally known to the public.

Water Quality and Pollution Control Reports

This product group includes a diversity of reports pertaining to water quality and pollution control in coastal waters, bays, and estuaries. Included in these reports are the results of studies of water quality and related problems for specific sites and bodies of water, beneficial use definitions, water quality objectives and discharge compliance reports.

These products are used by local, State, and Federal agencies responsible for determining water policy and enforcing pollution regulations. They are of importance to industrial, municipal, and private waste dischargers, and shore and coastal operations which may produce pollutants. Because of a lack of adequate data concerning marine water quality and the effects of various effluent components, it is not currently possible, in many cases, to define adequately objectives and management procedures.

With the exception of specific outfall monitoring reports, marine water quality and pollution data products produced at the present time are issued on an irregular basis. They are generally highly specialized and have very limited application and usage. There is a strong need for the collection and analysis of basic data. Additional products of a priority nature will be derived from

these data; however, it is not possible at this time to foresee the specific nature and contents of these products.

EXCLUDED DATA PRODUCTS

The products described here are those which did not satisfy the criteria of criticality and unfulfilled needs, i.e., these products did not score high on both criticality and unfulfilled needs.

Excluded Forecasting Products

Great Lakes Water Level Predictions

This product contains predictions of hourly water levels expected at stations bordering the Great Lakes and at the connecting entrances, locks, and canals. These predictions are essential only to the Great Lakes shipping operations and to the Great Lakes coastal engineering operation. It was found that merchant shippers operating deep draft vessels, fishermen, and shoreline residents are satisfied with the existing products. For this reason water level predictions were excluded from the priority product list.

Routing Charts and Revisions

These charts show the optimum track a vessel should follow in traveling between two points 1500 miles or more apart. Predicted weather and sea state conditions are the governing factors in ship routing. Revisions to routing charts are bulletins issued to correct planned routes due to deviations between predicted and actual weather and sea state conditions. Naval and MSTS routing is satisfactory, and merchant vessel routing is accomplished by commercial routing firms. Although the methods employed by commercial ship routers are not entirely satisfactory, only Federal products are the subject of this report. Therefore, this product was excluded.

Iceberg Advisories

These products are bulletins and facsimile charts describing the number of icebergs sighted, predicted positions, and the southern limit of their extent. Since the beginning of the International Ice Patrol in 1914, no ship has been lost due to an iceberg encounter in the patrolled area (Grand Banks and approaches). Thus the advisories presently fulfill all needs and are therefore excluded from the priority product list.

Excluded Descriptive Products

Navigation Tables and Publications

Navigation tables of primary interest to navigators include Azimuth Tables, Tables of Distances Between Ports, the Azimuth of Celestial Bodies, Astronomical Navigation Tables, and Loran Tables. Most of these products are published by the Naval Oceanographic Office. These tables and publications are used by vessels of all types in route planning, operational planning, and navigation. Since the users' needs are satisfied by the existing products, this category was excluded from the priority list.

Navigation Supplements

This products group includes issues of the Light List, Coast Pilot and Sailing Directions for foreign coasts. They include the information which cannot be conveniently shown on nautical charts, e.g., harbor descriptions, additional aids to navigation descriptions, instructions for waterways and harbors, signal systems, and pilotage services.

These supplements are used in navigation of vessels of all types. No unfulfilled needs were determined for this group of products.

Nautical Almanacs and Ephemerides

These products include the Nautical Almanac, the Air Almanac, the American Ephemeris and Nautical Almanac and the Astronomical Ephemeris, all published by the U.S. Naval Observatory. All are published annually except the Air Almanac, which is issued three times a year. They include data concerning the positions of celestial bodies; times of sunrise, sunset, moonrise, moonset, and beginning and ending of twilight; sextant altitude corrections; and other pertinent astronomical information.

The first two products listed are used in ship and aircraft navigation, respectively, while the latter two products, now unified, are of primary interest to astronomers and are too detailed for practical use in navigation. The needs of the users of these products are satisfied.

Standard Astronomical Tide Tables

These products are published annually for (1) the east coast of North and South America, including Greenland, (2) the west coast of North and South America, including the Hawaiian Islands, (3) Europe and the west coast of Africa, including the Mediterranean Sea, and (4) the central and western Pacific Ocean and Indian Ocean. They contain the predicted times and heights of high and low waters, for every day in the year, at primary stations, and methods for obtaining predictions for secondary stations.

Tide tables are utilized extensively in many operations in coastal waters. Tidal information for some remote parts of the world is inadequate for naval amphibious operations. However, the present products satisfy the great majority of user needs and on this basis astronomical tide tables are not included as priority products.

Tidal Current Tables and Charts

Tidal current tables are published annually for a number of waterways on the Atlantic Coast of North America and the Pacific Coasts of North America and

Asia. These tables include predictions of the times of slack water, the times and speeds of maximum flood and ebb currents, and methods for obtaining predictions for various locations.

Tidal current charts are published for various United States harbors. These charts depict the direction and speed of the tidal current for each hour of the tidal cycle, and are intended for use with the tidal current tables.

These products are used for navigation purposes and also have value in coastal operations and water pollution control activities. There exists a minor need for greater detail, but the products are satisfactory for most purposes.

Meteorological Reports

This group of products consists of a number of long term meteorological reports exclusive of climatological atlases; including, for example, meteorological journals, World Meteorological Organization (WMO) documents, instrumentation reports, and observer's handbooks.

These reports are used in forecasting technique development, in marine weather forecasting, and in marine observations. Time delays in their preparation and publication are considered to be a minor problem. No major unfulfilled needs exist.

METHODOLOGY EMPLOYED FOR SELECTION OF PRIORITY DATA

The methodology employed for the selection of priority data is identical to that employed for the selection of priority data products with the following exceptions:

- The criticality of data parameter groups was evaluated with respect to their significance to national security activities and in marine research, development and planning. Whereas

the primary emphasis in the delineation of priority products was on their significance to the operations and activities of important users of marine products, e.g., merchant mariners, commercial fishermen and recreational boaters, the delineation of priority data parameter groups was based on the significance of the data in increasing knowledge of the marine environment.

- The user of data in studies for research, development and planning, e.g., ocean circulation, was considered rather than operational applications, e.g., marine weather forecasting, as was the case for data products. The studies included in the delineation of priority data and their relationship to the data parameter groups are shown in Table II-1.

A large number of marine data parameters have been identified during this study. From these, 182 parameters were selected as being representative of the major measurements obtained in marine and marine-related activities. This list is not to be considered as all-inclusive, but rather as highly representative of the data utilized by marine users. In order to provide a more manageable number of data categories, this list of parameters was subdivided into 56 parameter groups by subject area (e.g., Tides, Radioactivity, Geophysical Measurements, etc.). These parameter groups were then organized into eight data types by research, development, and planning areas. The data types are: (1) Physical Data, (2) Chemical Data, (3) Geological and Geophysical Data, (4) Biological and Fishery Data, (5) Meteorological Data, (6) Pollution Data, (7) Engineering Data, and (8) Other Data. These data are indicated in Table IV-5.

The data parameter groups were then analyzed to determine (1) their use in the production of priority data products, and (2) their criticality in the conduct of research, development and planning studies. The results of this analysis are summarized in Table IV-6. The data parameter groups which are required to produce a priority product are classified as priority data. The relationship

TABLE IV-5

MARINE DATA TYPES, PARAMETER GROUPS, AND PARAMETERS

PHYSICAL

a. Pressure, Temperature, Density
- Pressure
- Water column temperature
- Sea surface temperature
- Water density

b. Currents
- Direction
- Velocity

c. Tides
- Water level
- Tidal period
- Tidal height
- Internal tide

d. Waves
- Wave length
- Wave period
- Wave height
- Wave direction

d. Waves (Cont'd.)
- Wave Surge
- Explosive waves
- Tsunami wave records
- Long-period oscillations
- Internal wave parameters

e. Swell, Surf
- Swell period, height, direction
- Surf conditions

f. Drift Measurements
- Drift bottle position.
- Swallow float position
- Seabed drifter position

g. Fresh Water Inflow/Water Exchange

h. Mixing Parameters
- Variances in distribution of spread
- Diffusion

CHEMICAL

a. Salinity

b. Nutrients
- Nitrates
- Nitrites
- Phosphates
- Silicates
- Ammonia
- Dissolved organics
- Trace elements

c. Buffer System
- pH
- Alkalinity
- Carbonates
- Carbon dioxide

d. Dissolved Gases
- Oxygen
- Helium
- Hydrogen sulfide

e. Radioactivity
- Carbon-14
- Cesium-137
- Strontium-90
- Tritium

f. Isotopic Ratios
- Oxygen-16/18 ratio
- Hydrogen/Deuterium ratio

g. Elements
- Concentration
- Chemical Form

TABLE IV-5 (CONT'D)

MARINE DATA TYPES, PARAMETER GROUPS, AND PARAMETERS

GEOLOGICAL AND GEOPHYSICAL

a. Rock or Sediment Samples
- Cores
- Dredges
- Drill cores
- Suspended sediment in water
- Airborne dust

b. Rock or Sediment Descriptions
- Composition: mineralogy, chemical & faunal
- Texture
- Structures (minor)
- Color
- Mass physical properties
  - Porosity
  - Acoustic velocity
  - Permeability
  - Geotechnical properties
  - γ log
  - SP log
  - Resistivity
- Mass chemical properties
  - pH
  - Eh

b. Rock or Sediment Descriptions (Cont'd.)
- Age
  - Biostratigraphic
  - Isotopic
  - Magnetic

c. Sedimentary Processes
- Transport
- Deposition
- Settling rate and concentration of suspended sediments
- Geochemical

d. Depth

e. Bottom Photographs

f. Geophysical Measurements
- Heat flow
- Seismic reflection
- Seismic refraction
- Seismic velocities
- Magnetics
- Gravity
- Seismograms, epicenters
- Seismicity

BIOLOGICAL AND FISHERY

Population Biology

a. Specimen Holdings

b. Taxonomic Position

c. Occurrence and Abundance
- Geographical
- Horizontal
- Vertical
- Seasonal

d. Primary Productivity Parameters
- Pigments
- Biochemical analysis
- Organic Carbon
- C_{14} uptake
- Bioassays

e. Collection Data
- Plankton tows and hauls
- Nekton tows and hauls
- Bottom tows and hauls
- Midwater tows and hauls

f. Migration and Movements

g. Age, Growth & Mortality

h. Fishery Statistics

Experimental Biology

a. Comparative Physiology
- Tolerances and regulation of internal environment
- Sensory physiology
- Metabolism
- Neurophysiology
- Diving physiology

b. Behavior
- Learning
- Reproductive behavior
- Biological rhythms

c. Population Genetics

d. Endocrinology
- Seasonal cycles
- Reproductive cycles

TABLE IV-5 (CONT'D)

MARINE DATA TYPES, PARAMETER GROUPS, AND PARAMETERS

METEOROLOGICAL

a. Air Characteristics
- Temperature
- Pressure
- Humidity
- Precipitation
- Visibility

b. Winds
- Speed
- Direction

c. Clouds
- Type
- Cover
- Altitude

d. Heat Budget
- Insolation
- Reflectivity
- Albedo
- Outgoing radiation
- Evaporation
- Condensation

e. Remote Sensing

POLLUTION

a. Chemical Pollutants
- Nutrients
- Oil - grease
- Industrial chemicals
- Detergents
- Pesticides
- Tetraethyl lead

b. Heat and Radioactivity
- Waste heat
- Radioactive waste

c. Microbial Pollutants
- Coliform bacteria
- Fecal coliform bacteria
- Fecal streptococci bacteria
- Pathogens
- Viruses
- Organic nitrogen

d. Other Solid Wastes

ENGINEERING

a. Wave Characteristics
- Wave forces
- Wave run-up
- Wave refraction, reflection, diffraction

b. Wind Forces

c. Current Conditions

d. Engineering Properties of Bottom

e. Sediment Transport & Coastal Erosion

f. Behavior of Materials

TABLE IV-5 (CONT'D)

MARINE DATA TYPES, PARAMETER GROUPS, AND PARAMETERS

OTHER DATA TYPES

a. Acoustics
- Sound velocity
- Frequency
- Absorption
- Intensity
- Range
- Sources

b. Electromagnetics
- Conductivity
- Dielectric constant
- Attenuation

c. Optics
- Color
- Absorption
- Scattering
- Reflection

c. Optics (Cont'd.)
- Refraction
- Radiance
- Polarization
- Transmission
- Attenuation
- Transparency

d. Sea Ice
- Ice drift direction
- Ice drift speed
- Ice deterioration
- Ice detection
- Ice concentration
- Iceberg shape
- Ice distribution

e. Biomedicine

Data Normally Recorded

- Ship
- Cruise
- Project & manager
- Ship heading and speed
- Time
- Geographic location
- Depth
- Sea state
- Weather conditions
- Other

TABLE IV-6

RESULTS OF DATA PARAMETER GROUP ANALYSIS

DATA TYPE	PARAMETER GROUP	PRIORITY PARAMETER GROUP: Used in Priority Product	PRIORITY PARAMETER GROUP: Not Used In Priority Product	NOT PRIORITY PARAMETER GROUP
PHYSICAL	Pressure, Temperature, Density	X		
	Currents	X		
	Tides	X		
	Waves	X		
	Swell, Surf	X		
	Drift Measurements	X		
	Fresh Water Inflow/Exchange	X		
	Mixing Parameters		X	
CHEMICAL	Salinity	X		
	Nutrients		X	
	Buffer System		X	
	Dissolved Gases	X		
	Radioactivity		X	
	Isotopic Ratios		X	
	Elements			X
GEOLOGICAL AND GEOPHYSICAL	Rock/Sediment Samples	X		
	Rock/Sediment Descriptions	X		
	Sedimentary Processes		X	
	Depth	X		
	Bottom Photographs	X		
	Geophysical Measurements	X		
BIOLOGICAL AND FISHERY (Population)	Specimen Holdings	X		
	Taxonomic	X		
	Occurrence & Abundance	X		
	Primary Productivity Parameters		X	
	Collection Data	X		
	Migration & Movement	X		
	Age, Growth & Mortality	X		
	Fishery Statistics	X		
(Experimental)	Comparative Physiology			X
	Behavior			X
	Population Genetics			X
	Endocrinology			X
METEOROLOGICAL	Air Characteristics	X		
	Winds	X		
	Clouds	X		
	Heat Budget	X		
	Remote Sensing	X		
POLLUTION	Chemical Pollutants		X	
	Heat & Radioactivity		X	
	Microbial Pollutants		X	
	Other Solid Wastes		X	
ENGINEERING	Wave Characteristics	X		
	Wind Forces	X		
	Current Conditions	X		
	Engineering Properties of Bottom	X		
	Sediment Transport & Coastal Erosion	X		
	Behavior of Materials	X		
OTHER	Acoustics	X		
	Electromagnetics	X		
	Optics	X		
	Sea Ice	X		
	Biomedicine	X		

of these data to priority products is indicated in Table IV-7. Other categories which are not required for the production of priority products are also designated as priority data because they are essential for the conduct of import... marine studies.

It should be noted that ancillary information normally included in the specification of acquired data (e.g., location, depth, time, sea state, cruise, etc.), are defined as a component of standardized data collection procedures. These ancillary data are not directly pertinent to the analysis. In the following discussion priority data will be considered within each data type and will include examples of use and unfulfilled needs.

PRIORITY DATA TYPES

Physical Data

Physical oceanographic data measurements are those which provide information describing the physical state and physical processes of oceans, lakes, and estuaries and their boundaries. Virtually all oceanographic investigations include some physical data measurements. The study of ocean circulation, which is fundamental to military and non-military maritime operations as well as to a general understanding of the oceans, utilizes measurements of water pressure (i.e., depth), temperature, and density; and of current direction and speed; of drift indicators; and, in some cases, involves observations of freshwater inflow, exchange, and mixing parameters with open bodies of water. Pollution studies currently underway, and those to be conducted in the future, will require physical data because of the influence of physical oceanographic phenomena on the dissemination and assimilation of pollutants.

All except one of the parameter groups which comprise the physical data type are required for the production of at least one and in some cases many of the priority data products. The most obvious requirements are for those products which describe or predict the physical state of the ocean waters (e.g., thermal structure forecasts, sea surface temperature charts, wave and swell charts, water column properties atlases, etc.).

TABLE IV-7
CORRESPONDENCE BETWEEN PARAMETER GROUPS AND DATA PRODUCTS

DATA TYPE		PHYSICAL								CHEMICAL						GEOLOGICAL AND GEOPHYSICAL						BIOLOGICAL AND FIS						
																						POPULATION						
PARAMETER GROUPS → / DATA PRODUCTS REQUIRING PARAMETER GROUPS ↓		PRESSURE, TEMPERATURE DENSITY	CURRENTS	TIDES	WAVES	SWELL, SURF	DRIFT MEASUREMENTS	FRESH WATER INFLOW/EXCHANGE	MIXING PARAMETERS	SALINITY	NUTRIENTS	BUFFER SYSTEM	DISSOLVED GASES	RADIOACTIVITY	ELEMENTS	ROCK OR SEDIMENT SAMPLES	ROCK OR SEDIMENT DESCRIPTIONS	SEDIMENTARY PROCESSES	DEPTH	BOTTOM PHOTOGRAPHS	GEOPHYSICAL MEASUREMENTS	SPECIMEN HOLDINGS	TAXONOMIC POSITION	OCCURRENCE & ABUNDANCE	PRIMARY PRODUCTIVITY	COLLECTION DATA	MIGRATION & MOVEMENTS	AGE, GROWTH, AND MORTALITY
PRIORITY SHORT-LIFE PRODUCTS																												
1	HEMISPHERIC WEATHER CHARTS	X																										
2	WAVE HEIGHT FORECASTS				X	X																						
3	LONG RANGE WEATHER FORECASTS	X																										
4	COASTAL WEATHER/WAVE FORECASTS	X			X	X													X									
5	HIGH SEAS WEATHER FORECASTS				X																							
6	TIDE WARNING BULLETINS			X	X	X													X									
7	TROPICAL CYCLONE ADVISORIES	X																										
8	SURF FORECASTS	X	X	X	X	X													X									
9	TSUNAMI WARNINGS			X	X	X													X		X							
10	IMAGERY PRODUCTS																											
11	ICE FORECASTS	X	X	X	X	X	X			X																		
12	SEA SURFACE TEMP. CHARTS	X																										
13	THERMAL STRUCTURE FORECASTS	X	X		X				X																			
14	ESTUARINE FLUSHING PREDICTIONS		X	X				X	X										X									
15	FISHERY PRODUCTS REPORTS																											
16	FISHERY ADVISORIES	X			X	X																					X	
PRIORITY LONG-LIFE PRODUCTS																												
1	CLIMATOLOGICAL ATLASES																											
2	WAVE AND SWELL CHARTS				X	X																						
3	SEA SURFACE TEMP ATLASES	X																										
4	SURFACE CURRENT ATLASES		X				X																					
5	ICE ATLASES																											
6	WATER COLUMN PROP. TABLES & ATLASES	X								X			X						X									
7	BATHYMETRIC MAPS																		X									
8	HYDROGRAPHIC SMOOTH SHEETS			X												X	X		X									
9	NAUTICAL CHARTS															X	X		X									
10	NAVIGATION NOTICES																		X									
11	OCEAN ENGINEERING HANDBOOKS	X	X	X	X	X		X	X										X	X				X				
12	GRAVITY & MAGNETIC FIELD MAPS																		X		X							
13	GEOL. & BOTTOM CHARACTERISTICS															X	X		X	X	X							
14	GEOL. & GEOPHYSICAL REPORTS															X	X	X	X	X	X							
15	FISHERY & SPORTFISHING ATLASES	X								X	X		X				X		X			X	X	X	X	X	X	X
16	FISHERY STATISTICS REPORTS																							X		X	X	X
17	CRUISE AND DATA REPORTS	X	X	X	X		X			X	X		X	X	X	X	X	X	X	X	X				X	X	X	

AND AL		BIOLOGICAL AND FISHERY												METEOROLOGICAL					POLLUTION				ENGINEERING						OTHER				
		POPULATION								EXPERIMENTAL																							
BOTTOM PHOTOGRAPHS	GEOPHYSICAL MEASUREMENTS	SPECIMEN HOLDINGS	TAXONOMIC POSITION	OCCURRENCE & ABUNDANCE	PRIMARY PRODUCTIVITY	COLLECTION DATA	MIGRATION & MOVEMENTS	AGE, GROWTH, AND MORTALITY	FISHERY STATISTICS	COMPARATIVE PHYSIOLOGY	BEHAVIOR	POPULATION GENETICS	ENDOCRINOLOGY	AIR CHARACTERISTICS	WINDS	CLOUDS	HEAT BUDGET	IMAGERY DATA	CHEMICAL POLLUTANTS	HEAT & RADIOACTIVITY	MICROBIAL POLLUTANTS	OTHER SOLID WASTES	WAVE CHARACTERISTICS	WIND FORCES	CURRENT CONDITIONS	ENGINEERING PROPERTIES OF BOTTOM	SEDIMENT TRANSPORT & COASTAL EROSION	BEHAVIOR OF MATERIALS	ACOUSTICS	ELECTROMAGNETICS	OPTICS	SEA ICE	BIOMEDICINE
														X	X	X	X	X															
														X	X			X															
														X	X	X	X	X															
														X	X	X	X	X															
														X	X	X	X	X															
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X	X																																
X	X																																
		X	X	X	X	X	X	X	X																								
				X		X	X	X	X																								
X	X				X	X	X		X		X	X			X	X			X	X	X		X		X		X		X		X	X	

Physical data are perhaps the most universally used type of marine measurements. For this reason their classification in the priority parameter group is warranted.

In spite of the widespread collection and use of these data, there exist significant voids. For example, complete descriptions of the world-ocean currents do not exist, either on an ephemeral or average basis; wave, swell, and surf data are available from some areas, but open-ocean records required for wave studies, for sediment transport investigations, and for engineering purposes are seriously limited. The few drift measurements which have been made have been taken in limited areas, so that their use in circulation and diffusion studies is severely restricted; and data on material and energy exchange between the sea surface and the atmosphere are sparse and not sufficiently accurate. Limited geographic coverage, few synoptic and time-series records, and inaccurate measurements are major deficiencies which adversely affect the usefulness of much of the physical data.

Chemical Data

The data parameter groups in this category are those which describe the inorganic and organic chemical constituents of marine waters. Chemical measurements relating specifically to waste assimilation are included in pollution data, chemical descriptions of bottom sediments are included in geological and geophysical data, and additional chemical data are included in the primary productivity parameter group under biological and fishery data.

The parameter groups comprising the Chemical Data ategory provide a more generalized decription of the chemical composition of marine waters and the marine environment. Salinity data are required for the preparation of water column properties atlases, nautical charts, and bathymetric maps.

Dissolved gases data are also essential for water column properties atlases. None of the other data parameter groups of the chemical data type are required for the production of priority data products; however, all chemical data are utilized in marine studies. With the exception of the elements group, the data are of broad interest and application and are included as priority data. The limited importance of data pertaining to specific elements, and the use of these data in only specialized research studies resulted in the exclusion of this group from priority data classification.

There are unfulfilled needs in salinity measurements for improved accuracy (up to the current claimed level of $\pm$ 0.003°/oo) in the deep waters of extensive areas where new instruments have not yet been used (Arctic Ocean, central Indian Ocean, western equatorial Pacific, southern Atlantic); and for increased observations in some shallow areas of the ocean where winter data are lacking. Studies of the seasonal effects of evaporation and precipitation, the contribution of salinity to the vertical density structure, and the deep thermohaline circulation all require improved accuracy, increased coverage, and more detailed observations.

The general structure of the oceans with respect to major nutrients is known very well for phosphates, but less well for silicates, rather poorly for nitrates, and hardly at all for ammonia. The last two are of paramount importance in governing the quantity and quality of the plankton and for monitoring pollution and the processes of aquaculture. A great deal more detailed coverage is needed, in combination with simultaneous measurements of the plankton in the euphotic zone.

Further information concerning the carbon dioxide (carbonate, bicarbonate, etc.) content of sea water will only be valuable if obtained with high precision. Such information would augment measurements of oxygen and salinity in delineating water masses, and would be of value in research

aimed at a better understanding of atmospheric and oceanic circulation and exchange. The analysis of sediments for carbonates and the carbon isotope ratios observed in carbonates is of value to geochemists in establishing conditions of sedimentation.

The unfulfilled needs for data on dissolved gases include those for nitrogen and the noble gases for use in general studies of the deep circulation, and for the non-conservative gases (oxygen and carbon dioxide) in biological studies. Data on the conservative gases are extremely limited. Data on gases, such as oxy , which exchange rapidly with the atmosphere are useful in studies of air-sea interaction and the vertical structure of the oceans. Data on those gases that exchange more slowly, such as carbon dioxide, are useful in studies of upwelling.

Natural radioactivity is still being used to measure turnover rates and other geochemical parameters, largely by using ionium-thorium and potassium-argon ratios; information relating to the rate of diffusion from sediments can be obtained by radium analyses; and tritium and carbon-14 data, which give information about oceanic circulation and mixing, continue to be of major interest.

Separate independent collections of chemical data exist in the marine research community, such as those at the Scripps Institution, Woods Hole Oceanographic Institution, the University of Washington, and others. Physical data collections also include related chemical information. A centralized collection point of chemical data--corresponding to, say, the National Oceanographic Data Center (NODC) physical oceanography data base--could serve the specialized and interdisciplinary needs of marine data users on a national scale. The establishment of a national chemical data base is considered to be an unfulfilled need.

Geological and Geophysical Data

The data parameter groups in this category are those which describe the geological, geochemical, and geophysical characteristics of ocean basins, continental shelves, and shorelines, and the dynamic processes which affect the crustal structure and seafloor geomorphology. Data parameter groups included in this category are fundamental to almost all types of oceanographic studies and, with the exception of sedimentary processes, are required for the production of a number of priority products including: bathymetric maps, hydrographic smooth sheets, nautical charts, navigation notices, ocean engineering reports, geological and geophysical reports, gravity, magnetic, and related geophysical maps, geological and bottom characteristics maps, and fishery and sportfishing atlases. Since the sedimentary-processes data are required for studies of major significance, all of the geological and geophysical parameter groups are classified as priority data.

The major unfulfilled need in the rock or sediment sample parameter group is for a system of master indexing which will include auxiliary data specifying the source of a sample, its location, and the status of processing and analysis of a sample. Rock or sediment descriptive data consist of the qualitative and quantitative information derived from the analysis and study of the samples. A precise summary of this information should accompany the basic sample citation in the Master Index in a format similar to that of the U. S. Geological Survey (USGS) and Woods Hole Oceanographic Institution (WHOI) marine geology data file. The NODC bottom sediment data files (with information on about 35,000 samples) constitute a suitable basic framework for the development of a Master Index.

Data concerned with sedimentary processes such as erosion, transport, and deposition are particularly vital in the design of offshore facilities such as drilling platform foundations, pipelines, and ocean outfall systems.

Another unfulfilled need is for an index or inventory of current studies including location, organizations making the studies, equipment, and techniques. Another is the requirement by the offshore mining industry for research and data which would facilitate the control of dredge tailings in offshore operations. Virtually no statistical data exist on the distribution of placer minerals within an ore body; data of this type are critical to the design of mining equipment.

Depth data, indicating the seafloor topography, are basic input for the production of bathymetric maps and charts. As an indication of the voluminous nature of such data, the Naval Oceanographic Office (NAVOCEANO) bathymetric files contain more than 40 million soundings and receive input at the rate of some 3.7 million soundings per year With the development of sophisticated bottom topography submarine navigation systems, the requirement has increased for detailed bathymetric charts of extensive ocean areas. Accordingly, there is a major need for such bathymetric data from most of the more remote ocean areas of the world (e.g., portions of the Pacific, much of the Indian, and most of the southern oceans).

Marine geophysical instrument systems (e.g., seismic reflection and refraction, magnetometer, scintillometer, and gravimeter) produce enormous volumes of analog and digital data. For example, NAVOCEANO ship-borne magnetometer systems generate some two million data points per year, and their gravimeter program generates 460,000 observations per year. A single Coast and Geodetic Survey offshore gravity survey produced nearly a thousand sea surface gravity readings and 90 seafloor readings.

In some instances, such as the NAVOCEANO Marine Geophysical Survey Program,[1] funds were available for collection, compilation of data, and for specialized

[1] U.S. Naval Oceanographic Office Marine Geophysical Survey Program 1967-1968; Western North Atlantic and Eastern and Central North Pacific Oceans, July, 1967. Contract N62306-1688 with Alpine Geophysical Associated, Inc., Norwood, N. J. Contract N62306C-1687 with Texas Instruments, Dallas, Texas, for the Eastern North Atlantic; Contract N62306-2020 for the Western North Pacific with Alpine Geophysical Associates.

interpretation, but not for detailed analysis, even though the data have potential for major advances in the understan``ng of the ocean bottom. Another unfulfilled need is a master indexing of geophysical programs which specify location, equipment, and sponsors.

Biological and Fishery Data

There are three subtypes of data included within this category: population, fishery statistics, and experimental data. The first subtype is composed of parameter groups which describe the geographic distributions of marine organisms, the ecology of species and populations, environmental data, and the structure of populations of marine organisms. These parameter groups include the very important derived biological information required for military operations; i.e., scattering layer composition and migrations, marine foulers, bioluminesence sources and distributions, and biological noise sources and distributions.

Specimen holdings consist of preserved organisms (in some cases living cultures) obtained during collecting trips and detailed collection data. These specimens provide the authoritative source of information for studies concerned with taxonomy, distribution, and related subjects. They provide the ultimate source of data for fishery and sportfishing atlases. Unfulfilled needs include increased accessibility of the collections and increased documentation of the collections. An index of available collections, or the publication of collection catalogs, is desirable.

Taxonomic data are required for all biological studies and analyses. The occurrence and abundance of species of interest is also information of importance in studies of biogeography, marine productivity, life cycle studies, and population studies. The data in this group are either scattered in technical publications, unpublished, or published long after the observations are taken. Timely cataloging of these data would resolve this problem.

The Primary Productivity Parameter Group contains the most fundamental marine biological data, since these parameters determine the overall bioproductivity of the region under study. The production of fish and other organisms of potential economical value is a direct function of primary production by algae, the base of the food chain. These data are also important in the water quality and pollution control area since waters which receive wastes are enriched with the basic nutrients for primary producers. The assimilative capacity of a body of water is determined largely by the concentration of these nutrients. The major unfulfilled need in this area is for a more accurate and direct means of measuring primary productivity in a body of water. Other needs are for an increase in the quantity of seasonal data and the development of data bases for these data.

Collection data include collection methods, depth, locality, season, time of day, associated biota, etc. These data also require cataloging. Migration and movement data are important for fishery studies of population dynamics, as are data concerning age, growth, and mortality.

Fishery statistics of an economic nature are collected on landings, receipts, supplies, prices, imports, holdings, movements of fish and fish products in local areas, and market conditions and fishery developments in the U. S. and foreign countries. Economic fishery statistics are utilized by the fish processing and distributing industry for routine economic studies in their daily business operations and for the conduct of research studies of the fishing industry. The same data are used in establishing Federal fishing policy and programs.

Statistics on catch, fishing effort, gear type, vessel characteristics, tagging, morphometrics, sex, spawning, and serology are of particular importance to fishery research. Fishery statistics are used by fishery scientists for the development of population dynamics models for determining: (1) the effects of fishing on fish populations; and (2) the maximum sustained yield possible while maintaining the resources at their optimum level.

Unfulfilled needs regarding fishery statistics are summarized below:

- Lack of fishery statistics on the involvement of U. S. companies in international fish production, processing and marketing.
- Lack of statistics on foreign fish production, processing and marketing.
- Lack of timeliness in collection, processing and distribution of fishery statistics.
- Lack of completeness of statistics (i.e., no data on incomes, investments, operating costs, etc.).
- Lack of integration of daily, weekly and monthly fishery statistics with other pertinent fishery information, such as fishing fleet activities and long term market trends.
- Lack of statistics on sportfisheries.

The third data subtype (experimental) includes parameter groups which are of interest primarily to the experimental biologist. None of these groups are required for the production of priority products. Comparative physiology data are concerned with the physiological systems of differing species, behavioral data (as distinguished from migration and movement data) are concerned with instinctive and conditioned responses in relation to environmental demands, population genetics data are used for the study of fish population dynamics, and endocrinology data are concerned with the hormonal systems of various species. Since all of these data parameter groups are of almost exclusive interest to research projects, and the data are collected for very specific and limited purposes, none were included as priority data.

Meteorological Data

The data parameter groups in this category include those which describe weather conditions over ocean and coastal areas. Most of these data are collected on a synoptic basis and priority meteorological and climatological products are derived from the synoptic data. Air characteristics including cloud and wind data are basic for the production of analyses and prognoses, and are also used for wave height forecasts, surf forecasts, and storm surge advisories. Heat budget data are used primarily in long range forecasting.

Remotely sensed data from satellites are used principally as a valuable adjunct in weather forecasting (in the location of large scale weather systems and associated fronts, for example) and are therefore included as meteorological data. Recent technological developments in remote sensing from satellites indicate the development of practical data gathering techniques in other areas, including mineral signature identification, sea surface temperatures, sea state conditions, and biotic mapping.

Pollution Data

The pollution data parameter groups include measurements of the various kinds of organic, inorganic, and biological materials of importance in water quality control. These data are essential to Federal, State and municipal agencies in determining the existing quality of marine waters, in establishing procedures to maintain or improve these levels, and in designing and implementing monitoring and enforcement programs. These data are also of importance to municipal sanitation agencies, industrial dischargers, utility companies (thermal discharges), fish and game agencies, and recreation and conservation groups.

The greatest density of data is required from bays, estuaries, sloughs, harbors, marinas, and the surf zone; however, offshore data are also required, particularly in the vicinity of outfalls. Some marine pollutants, such as pesticides and lead, are detectable in open ocean waters. At the present time pollution data are collected on a routine basis only for purposes of monitoring outfalls, or in areas where special problems exist. The waste assimilation capacity of marine waters is not firmly established except for some areas where it has been surpassed. The Federal Water Pollution Control Administration (FWPCA) has recently required State agencies to establish water quality criteria for marine waters (which are defined as interstate waters in most cases), and a no-degradation policy has been firmly stated.

Water quality criteria are standards to be maintained in terms of all sources of pollution. At the present time very little is known about the factors which determine marine water quality, particularly in terms of the biological consequences of changes in the marine environment. In view of these extensive data requirements, all of the parameter groups are of high priority.

Engineering Data

Engineering data encompass those parameter groups which are essential for coastal and ocean engineering design, planning, and operations, and include: a) environmental data such as wind and wave forces, sea floor foundation characteristics, etc., and b) non-environmental data such as behavior of materials, data on sensors, biomedical data, and test facility data. The environmental data for engineering use are generally derived from other data categories. For example, wave characteristics and current conditions are derived from physical data; wind forces from meteorological data; and engineering characteristics on the sea floor, of sediment transport, and of coastal erosion are derived from geological data. The non-environmental data may be general engineering data (for example, data on power sources

and energy conversion), or they may be unique to ocean engineering (e.g., response of materials to the marine environment). All of these data parameter groups are classified as priority because they are either from other priority data categories or are required in ocean engineering operations of major significance.

Data concerning the forces exerted by waves, and the effects of wave refraction, reflection, and diffraction on coastal and offshore structures are essential in selecting design criteria such as maximum wave height and force.

The major unfulfilled needs in this parameter group are for a more precise understanding of the relationship between wave forces and structural response in offshore structures, more intensive collection of wave effects data from offshore structures, and study of the effects of wave trains more complicated than those now studied in wave tank models.

Wind characteristics data are important both in terms of effects on structures and in terms of coastal erosion, tidal hydraulics and surging, and effluent dispersion. There is a requirement for data on coastal winds, which are needed for forecasting wave and surf conditions, runup, and surge.

Data on current conditions have many engineering applications, including design studies of effluent dispersion, predictions of sediment scour around foundations of offshore structures, and sedimentation in navigation channels. The unfulfilled needs include: (a) comprehensive collection programs for shallow water currents data needed for coastal waters adjacent to population centers and offshore industrial sites, and (b) an effective means of canceling out the effects of orbital wave motion on instrument-observed shallow water current data.

Data concerned with sediment transport and coastal erosion, which are required for the design of structures and navigation channels, are normally obtained by detailed site investigations, but the usefulness of wave data necessary for selection of design criteria generally depends on the time span of historic records. With the exception of the valuable compilations by Coastal Engineering Research Center (CERC)*, wave data are generally inadequate because of the time-span of the records or remoteness of area. In addition, data on average breaker height, which are extremely useful in longshore sediment transport studies, require improvement because of inadequate measurement techniques and the scarcity of instrumented observation stations. Another unfulfilled need is for the release of the backlog of wave data at CERC.[1]

The data included in the Behavior of Materials parameter group are concerned with the effects of the marine environment (including the effects of organic fouling and corrosive bottom sediments) on engineering materials, such as various steel alloys, glass, and synthetics such as nylon. A major unfulfilled need is for data concerning the response of materials in water depths greater than 2,000 feet.

Major unfulfilled needs for all ocean engineering data caregories are:

1. The requirement of an index of data producing organizations and locations of the corresponding data.

2. Although there is intense public use (industrial, recreational conservationist, etc.) of the coastal and nearshore zones, environmental engineering data from these zones are surprisingly sparse and scattered. There is a major need for systematic investigation, charting, mapping, and measurement of the

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[1]The Wave Record Program at CERC by John M. Darling, and Demetrius G. Dumm, U. S. Army Coastal Engineering Research Center Miscellaneous Paper No. 1-67.

oceanographic characteristics of the shallow water nearshore environment, with presentation of the analyzed data as a series of comprehensive atlases and statistical summaries.

3. The potential for multiple use of the Navy-established diving accident data base (a unique national resource) could be substantially increased by more widespread dissemination, particularly to industry, of the various research and annual statistical reports of the Navy Experimental Diving Unit.

Other Data

Acoustics

Data on underwater acoustic properties are used in nonmilitary as well as military programs. Nonmilitary requirements for acoustic data are expanding. Uses occur in connection with scientific investigations of biological sound sources, the development of underwater communications systems, underwater habitats, and geological and bathymetric surveys. Most military uses are classified. The data are used to develop design and performance criteria for ASW and undersea warfare (USW) systems. The importance of acoustic data is indicated by the fact that over one-half of the Navy's R&D budget for oceanography is allocated to underwater acoustic work. Two priority long-life products are based on acoustic data: the U.S. Naval Oceanographic Publication 700, Section VI, Sound Velocity, which presents the average seasonal sound velocity structure in the north Atlantic and related areas; and the Sonar Range Atlases (classified).

The behavior and utilization of underwater sound are functions of water temperature, temperature gradient, salinity, pressure, viscosity, ambient noise, ocean bo[illegible] and sea surface conditions, and characteristics of the acoustic transmitter and receiver. Because environmental properties are ephemeral and depend on the geographical area of interest, the continuous collection of environmental data is essential to the improvement and under-

standing of marine acoustics. For this reason and in view of the use of such data in priority products, acoustic data are considered to be priority parameters.

Electromagnetics

Contemporary investigations utilizing electromagnetic data include basic research into the earth's structure beneath the oceans, research into the effect of the earth's magnetic field on oceanic currents, underwater communications by electrical means, electrical hazards to divers, and electrical insulation properties of materials. Some of these data would be included in an ocean engineering handbook. The unfulfilled needs are nonspecific and relate primarily to research areas.

Optics

The optical properties of sea water and the use of optical materials in submersibles and underwater camera and television systems are becoming increasingly important. Optical data are highly important to the military in ASW, mining, and mine countermeasure operations. Sea water optical measurements are used in studies of photosynthesis in marine plants and animals, in assessment of pollution conditions, in the development of oceanic resources, and in the development of materials and lighting systems for underwater visibility. New designs for search, rescue, salvage, and research submarines, both manned and unmanned, require viewing capability, and this in turn requires knowledge of the optical behavior of different light sources and materials for directly and indirectly viewing underwater illuminated objects. Some optical data would be included in an ocean engineering handbook. Limited applicable optical data are being generated at widely scattered facilities, including both private research institutions and Navy laboratories.

Sea Ice

Data on sea ice include information on the extent, concentration, and composition of ice cover; speed and direction of ice drift; occurrence and concentrations of icebergs; physical and engineering properties of sea ice; extent and duration of major intrapack open water areas such as polynas, etc. Sea ice data are essential to making operational forecasts of ice conditions. Iceberg warnings are important to shipping which transits ice areas such as the Grand Banks, and information on ice pack characteristics (particularly movement) is essential to ice navigation and to the design and construction of harbors in ice areas. Priority data products which require sea ice data are ice forecasts and ice atlases. From the point of view of basic research there is need for considerably more detailed information on variations in polar ocean pack ice cover. This need derives in part from the opinion of some experts who consider the intense heat sink effects of temporarily open water areas (large polynas) to have a major bearing on the periodic outbursts of cold polar air which substantially affect northern hemisphere weather.

Biomedicine

Data included in this parameter group are those which relate to the health, safety, and performance of crews involved in underwater operations. These data include information on underwater physiology, diving equipment, behavior, the ecology of closed environments (including undersea habitats), hazards, and accidents. Military uses of these data are in submarine and deep submersible operations, salvage operations, undersea habitat operations, and other diving operations. Nonmilitary users include commercial diving concerns engaged in industrial offshore investigations, construction, and operations and in salvage operations. Recreational scuba divers also provide a large number of users.

These data are important for developing new technology and new techniques for oceanographic studies. For this reason biomedical data parameters are included as priority items.

The major unfulfilled needs are in the general area of deep water manned operations and extended habitation in undersea shelters. Specific data needs are for further definition of performance limitations in terms of physiological and psychological factors, and in terms of specific environments and support equipment. At the present time there are wide variations in diving tables and schedules. Standardiz·tion of these products would resolve this problem.

PROPOSED IMPROVEMENTS TO EXISTING MARINE DATA AND PRODUCTS

FORECASTING PRODUCTS

Hemispheric Weather Charts

The main improvement of hemispheric weather analyses and prognoses will come from research and development on NWP modeling. Some improvement can be expected by improving the observational network. Improved operational use of hemispheric weather charts will result from faster dissemination and improved internal procedures. The processing cycle at NMC could be speeded up by more automatic handling of data and by implementation of higher speed data transmission of current observations. Transmission of ship observation data could be improved immediately by utilizing the U.S. Coast Guard Automated Merchant Vessel Reporting (AMVER) System communications network. Most of the vessels participating in the AMVER program are also those reporting weather information. In numerous cases, these vessels have submitted their weather reports with their position reports, and the weather data have been retransmitted to the NMC. The AMVER network is operational 24 hours a day and

could provide rapid weather reports in all cases except when a search and rescue operation is underway.

All Naval Weather Service Command numerical hemispheric analyses and prognoses are produced and were developed at FLENUMWEACEN. The weather analyses and prognoses are objective schemes designed to analyze exactly to isolated observations and to a weighted-mean of the observations in regions of dense data coverage. In sparse data areas, the influence of an observation is extended further than in regions of high data density.

Receipt of 98% of raw meteorological observational data is via the USAF Automated Weather Network (AWN) by computer-to-computer transmissions. By constant attention to quantity and distribution, both the USAF Air Weather Service and the Naval Weather Service Command ensure adequate data coverage.

Upon receipt the raw observational data is decoded and reformatted for the analysis. The analyses consist of various routines such as the First Approximation, Gross Error Check, Analysis Scheme, Lateral Fitting Check, and Vorticity Limiting Check.

The processing cycle is handled in an automated fashion with various computers utilizing storage devices jointly and a minimum of tape handling. This minimizes the slow and unreliable human element. Computer output is normally a magnetic tape or printer output. Display device (X-Y plotter) pen commands stored on magnetic tape are run off-line to drive the device.

Computer output, in the form of compacted hemispheric fields, is also transmitted computer-to-computer to FLEWEACENs via the high speed data links of the Naval Environmental Data Network. This information is then processed locally to generate the pen commands for the off-line display device.

Wave Height Forecasts

Prior to October 1, 1968, FNWC Monterey and the associated Fleet Weather Centrals were the only source of wave forecasts. Since October 1, 1968, NMC has been producing 24 and 36 hour wind-wave, swell, and combined sea and swell predictions twice daily for dissemination to marine and other coastal forecast centers. The predictions are based solely on wind fields computed from the surface pressure prognosis. If this prognosis is obviously in error, the wave heights should be used with caution.

Improvements in these predictions will be accomplished as improvements in the primitive equation numerical model and empirical constants are achieved. To increase the availability of these forecasts, ESSA plans to establish a civilian facsimile and communication network seaward which will be implemented to provide transmission on a firm schedule. In addition, computed wave data should be included on the PE Merged Output Tapes that are archived at EDS (NWRC) so that all related meteorological data would be stored together. Improvements in the FLENUMWEACEN predictions will be accomplished as improvements in the surface pressure prognosis model are achieved. Additionally, the analysis and prognosis are being monitored and the program is continually being tuned to provide products as accurate as possible.

Extended Range Weather Forecasts

Research is underway at NMC to develop numerical forecast methods. Input data requirements have been identified, but collecting agencies have not received detailed specifications for the collection of data on an operational basis. Input data requirements in digital format include sea surface temperature data without overlap over land areas, snow and ice boundary data, albedo and cloud cover data, and thermal profile of the ocean to the thermocline. Improvements will also result when data on turbulent transport and excess radiation in the troposphere and at the surface, in conjunction with overall heat budget information, are made available on a regular basis.

The Naval Weather Service Command is developing an Analog Extended Range Weather Forecast technique at FLENUMWEACEN. Acquisition of a large computer and development of a hemispheric historical data base permits better utilization of pattern separation derivations in analog studies. Thus, the system under development allows more advanced exploitation of analog techniques than has heretofore been possible. Using these recently acquired capabilities, FLENUMWEACEN is routinely producing several experimental extended outlooks as well as hemispheric predictions out to ten days.

Coastal Weather and Wave Forecasts

These predictions are made at 15 of the area forecast centers in the coterminous U.S. for the 10,000 miles of coastline plus Anchorage, Honolulu and San Juan. Offshore oil operators, skin divers and amusement pier operators desire highly localized forecasts, which are presently not being provided by these centers.

These forecasts are prepared four times daily using guidance products from NMC, ship and station reports, a few local supplemental observations, and satellite photos. Forecasters are assigned to this task as an additional function to the production of continental forecasts.

In order to prepare forecasts for specific areas, supplementary observations in the proximity of the area are needed. Depending on the geographic features of the area, additional observations would improve predictions, assuming that full time marine forecasters would be assigned to each forecast center to receive and analyze the data and make the forecasts. Many platforms and sources exist which could be employed for collecting local data. These consist of offshore oil platforms, state and federal parks maintained by full time personnel, Coast Guard stations, marinas, and lifeguard stations.

The Naval Weather Service Command provides these forecasts for DOD users on a worldwide basis. Coastal and wave forecasts are made at all of the Naval Weather Service Command activities and are prepared using local observations, FLENUMWEACEN hemispheric analyses and prognoses and locally prepared analyses.

High Seas Weather Forecasts

These forecasts are made four times daily at three Weather Bureau area forecast centers and transmitted over Navy and civilian operated facilities in Washington, D.C., San Francisco, and Honolulu. The forecast centers use guidance products from NMC, satellite photos, ship and station observation reports, and climatological statistics to derive forecasts. Extensive use of the guidance products and satellite photos are dependent upon their timeliness and accuracy.

Presently, marine forecasting assignments are made on a rotating basis and are considered additional to other assignments. Specific assignment and training of personnel in marine forecasting techniques would improve the quality of forecasts, and would foster improvements in marine forecast techniques.

The Naval Weather Service Command provides these forecasts for all DOD users. High Seas Forecasts are made at the Naval Weather Service's Fleet Weather Centrals for their individual areas of responsibility. In preparing these forecasts, unique observations, FLENUMWEACEN hemispheric analyses and prognoses, and locally prepared analyses are utilized.

Storm Surge Advisories (Storm Tide Warning Bulletins)

Tropical cyclone advisories including storm surge information are issued from the Hurricane Warning Office and the National Hurricane Center. Storm tide warning bulletins are issued by the Warning Coordination Centers at Boston,

Washington, Miami, New Orleans, Los Angeles, San Francisco and Seattle for their respective areas of responsibility. In addition, local Weather Bureau offices issue statements which indicate the local effects of storm surge. The needs of the public for more localized forecasts are not being met because of the lack of marine forecasters and because forecast areas are too broad (20 centers cover the entire coastal area).

When severe storms are detected, the responsible offices generate storm surge advisories by examining the size, intensity, location, and movement of a given storm relative to the previous storms for that area. (These parameters are available or can be easily derived from the numerical prediction model outputs.) The storm information is based on historical data for each station. The storm parameters are received from NMC in the form of charts.

A storm surge prediction model has been proven satisfactory for the Atlantic City area. Increased implementation of numerical models to produce storm surge advisories would decrease the time between synoptic analysis and dissemination, relieve local forecasters of this task, and would provide consistent predictions for as small an area as required.

The Naval Weather Service Command is responsible for preparing these advisories for DOD users.

Tropical Cyclone Advisories

These advisories are produced at and issued from the National Hurricane Center at Miami and the Weather Bureau Hurricane Warning Offices at Boston, Washington, San Juan, New Orleans, San Francisco and Honolulu. All offices receive guidance material from NMC, observation reports from ships in the area, aircraft reconnaisance reports, satellite photos, and radar information.

The forecast offices need to be upgraded and programs established to improve the prediction of cyclogenesis and cyclone movement. The National Hurricane Center employs a numerical forecasting model.

Sea surface temperature measurement of one nautical mile resolution and 1°C precision, which is required in the tropical ocean areas to aid in predicting cyclogenesis, is presently unavailable. In those areas where little observation data are available (such as the eastern Pacific) satellite photos are the only reliable source of data, and some of these data may be 12 hours old by the time the forecast centers receive them. Prediction of cyclogenesis by the Weather Bureau is made only in the Atlantic, where the observation net is most dense. However, these predictions are still inadequate. Additional observation stations have been specified for this region. At every forecast office, except the NHC, personnel make the predictions as additional tasks. The methods employed are subjective and vary with the forecaster.

Assignment and training of forecasters in meteorology and physical oceanography, as called for in the Federal Plan for Marine Meteorological Services (May, 1968), would aid in the development of consistent forecasting techniques.

The Naval Weather Service Command prepares and disseminates all tropical cyclone and typhoon advisories in the western Pacific through the Joint Typhoon Warning Center and disseminates hurricane advisories to the U.S. Naval community. Additionally, warnings may be issued by the local Naval Weather Service Command activity. Data input for these forecasts include numerical and hand analyses and prognoses, satellite photos, local observations, and steering techniques.

Surf Forecasts

Only one marine forecaster is assigned full time to provide surf forecasts in Southern California, and only one other forecaster is doing developmental work in surf forecasting over sandbars in Newport, Oregon. They both use

nomographic methods developed by Bretschneider, Sverdrup, and Munk. A primary need was recently satisfied by the availability of wind-wave and swell forecasts from NMC.

A present need is for the installation of wave sensors in those waters with a direct exposure to expected waves and swells from the open ocean and the telemetering of data to local forecast offices. This would provide coastal sea state forecasts for use in conjunction with offshore wind and weather forecasts.

Additional forecasters trained in marine meteorology and physical oceanography would provide the capability required to forecast surf for other U.S. beaches.

The Naval Weather Service Command prepares these forecasts for DOD users. Forecasts are made by the local Naval Weather Service Command activity and are prepared using local observations, FLENUMWEACEN hemispheric analyses and prognoses and locally prepared hand analyses.

Tsunami Warnings

Tsunami warnings are issued from the Tsunami Warning Center in Honolulu where undersea earthquakes have been detected, to the stations nearest the epicenter. When a seismic sea wave has been detected at a tide station, warnings are issued to other areas that could be affected. There presently is no method to predict the occurrence of a tsunami from a seismic disturbance, nor predict its magnitude at other stations other than using

historical tsunami records. Travel time predictions are accurate to within two and one-half precent of total travel time. The present seismological station network is adequate for locating a seismic disturbance and for travel time prediction, and the existing wave stations provide adequate geographic coverage. The important need is for a method to predict the occurrence of seismic sea waves.

Products Obtained From Satellite Remote Sensors

Photographs showing cloud cover on a global basis are the most widely used NESC product. From these photos (and/or on the basis of video data) NESC produces weekly ice and snow cover charts, mean brightness charts, and daily global mosaics. These products are archived both at NESC and NWRC. Infrared photos have been taken on an experimental basis. Vertical temperature profiles of the atmosphere have been obtained from the recently launched NIMBUS B Satellite. It is anticipated that wind data can be derived from the atmospheric temperature measurements.

Processing tasks are performed primarily on a CDC 6600 system shared with NMC. When this system malfunctions or is down for maintenance, satellite transmissions are not received. During September, 1968, 49 transmissions (12 percent of total for the month) were not received. NESC software development is also delayed because a computer is not available solely for NESC use. Plans exist to procure a second CDC 6600 system to provide increased processing capability. In addition, software development to provide wind velocity derivations from cirrus plumes, and to support new experiments in atmospheric temperature profiling and sea surface temperature mapping, will be accelerated by acquisition of a second computer.

Fishery Product Reports

Information on landings, prices, demand, supplies, movements, and other factors affecting day-to-day marketing of fishery products and byproducts are distributed five times a week by seven Bureau of Commercial Fisheries (BCF) Market News Offices. Data and information for these reports are gathered on log forms and punch cards through personal contact with fishermen, processors, and distributors by BCF personnel stationed in some 42 branch statistical offices. Daily information, such as prices, supplies, etc., is transmitted via telephone, while other data, such as imports, are compiled and transmitted either on a weekly or monthly basis for later inclusion in daily issues of the Fishery Products Reports.

During the Part I survey of the fishing user community the plea for current and forecasted fisheries information was heard repeatedly. The daily dissemination of current and forecasted statistics on fish yield, processing and distribution would improve the functioning of the fishery products market. At present, most fishery statistics are obtained by the fish processing and manufacturing industry via its own intelligence networks and supplemented with the information contained in the BCF daily Fishery Product Report. Commercial fishermen are at a disadvantage when bargaining for prices, since they must rely on the incomplete information supplied by BCF.

Fishery Products Reports now cover all the major U.S. fisheries; however, this information is not presently being synthesized on a national scale to provide industry and government with the daily, weekly, or monthly national situation and outlook. Currently, there is a two year time lag in the production of the BCF annual fisheries statistical digest. Thus, the complete current fisheries picture is never available to industry or government on a timely basis.

A goal is to develop a service similar to that provided for U.S. agriculture, where current prices, supplies, etc., are available on a much more current and complete basis. Reports of current prices, landings, etc., versus historical trends, in conjunction with analysis of these data should be provided. This would require the development of statistical fisheries data bases in a format suitable for this purpose. It would also require that certain aspects of daily fishing fleet activities such as deployment and operations be integrated with the information now provided by the Fishery Products Reports.

At the present time BCF has neither the capacity nor an adequate number of data collection personnel for developing a national Fishery Products Reports system. It has been found that cooperation of the fishing industry cannot be obtained unless there is contact between the statistical gathering staff and the industry. Absolute assurance must be given to all participants that the records they provide will under no circumstances be made available to any unauthorized person or agency. Current BCF long range plans do not include efforts for increasing the coverage and completeness of the Fishery Products Reports, nor for upgrading their computer capability to cope with deficiencies in Fishery Products Reports. BCF long-range plans should therefore be re-evaluated in light of the needs for providing improved Fishery Products Reports.

Fishery Advisories and Pre-abundance Forecasts

In 1966 the BCF Fishery-Oceanography Center at La Jolla, California established a daily fishery information service for the albacore fishing fleet in the eastern North Pacific. Although sea surface temperature and weather charts are transmitted from FNWC, Monterey, to BCF, La Jolla, via data link, there are delays in providing the charts to the fishing fleets. Biweekly and monthly sea surface temperature charts prepared by BCF are received by the fishing industry via mail. In addition there is inadequate communication of catch and environmental data from fishing fleets to BCF while they are at

sea. Very little catch data collected for the Fishery Products Reports is integrated with environmental data for the purpose of predicting the location and abundance of fish and providing this in a form understandable to the commercial fishermen.

Fishery advisories are issued during the fishing season and are concerned primarily with predicting the location of fish. Pre-season abundance forecasts are concerned with predicting the abundance of fish in a given fishery priir to the opening of the fishing season. Additional research is required in order to ascertain the relationship of fish location and abundance with environmental and population factors before fishery advisory and abundance forecast services can be completely specified for other fisheries. However, one of the first steps toward the establishment of additional fishery advisory and forecast services would be to make an inventory of existing data bases in order to determine the availability of data for the development of these services.

DESCRIPTIVE PRODUCTS

The long life priority products produced by Federal agencies are prepared for three areas: the Great Lakes, the U.S. continental shelves, and worldwide. The areas covered by the various agencies for a given product are indicated in Table II-2. The current and future activities of the agencies in terms of geographic coverage within the three areas are primarily designated as:

- maintenance of products for geographic areas presently covered;
- compilation of additions necessary to achieve complete geographic coverage;

- present coverage of selected areas but with plans for complete geographic coverage;
- geographic coverage of selected areas; and
- no current activities.

The agencies which maintain data bases required for the production of the long life priority products are indicated in Table III-2.

Marine Historical Environmental Products

The Naval Oceanographic Office (NAVOCEANO) is the major producer of marine historical environmental products, e.g., wave and swell charts, surface current charts, and ice charts. There are two major activities being carried out by this agency: maintenance of classified National Intelligence Survey (NIS) products and preparation of an unclassified series of products (HO 700 series), using the same data base. The HO 700 series for the North Atlantic is not yet complete. A similar series is being produced for the North Pacific and Indian Oceans. The Environmental Data Service, in cooperation with the WMO, is planning to issue climatological atlases for the Great Lakes, U.S. continental shelves, and world oceans; and the Coast and Geodetic Survey is considering producing a set of marine historical environmental products similar to the HO 700 series.

Most of the climatological and water column properties data are available from single data bases; however, the wave and swell data, sea surface temperature data, surface current data, and ice data are held by several agencies. Consolidation of these data bases would facilitate the preparation of products.

The environmental data are processed differently depending upon whether they are presented in the product as statistical summary symbols (e.g., wind roses) or contours (e.g., sea surface temperature). Symbols are commonly used for wind direction and velocity, surface current direction and velocity, and wave and swell height, period, and direction. Historical data for these parameters are statistically analyzed by computer to determine means and distributions for a given period of time (e.g., monthly) for a defined area (e.g., one degree square). The computer output is either a listing or is plotted automatically for further analysis. Certain statistical summary symbols are prepared as on-line CRT displays and then photographed for reproduction in products.

Data which are usually contoured include air temperature, precipitation, visibility, total cloud percentage, air-sea temperature differences, dew point, sea surface temperature, percentage of wave height observation greater than standard heights, ice coverage, ice thickness, thermocline depths and vertical and horizontal sections of temperature, salinity, density, and oxygen content. These data are analyzed statistically for averages and for percentages of observations greater than standard levels. They can be rough-plotted by an automatic plotter and revised and smoothed by hand, or they can be hand contoured from the digital plot. The present Naval Oceanographic Office environmental data bases require additional manual processing in order to put the data in a format acceptable for computer processing.

The major sources of continental shelf ship observations are Light Ships and transoceanic merchant and Navy ships when operating in continental shelf areas. Naval ships on short cruises, training exercises or shore support operations; Coast Guard cutters on local search and rescue operations; fishing boats, and offshore oil towers, seldom submit surface observations. Very few local Coast Guard units, lighthouse

operators, lifeguards, park operators, tide gauge observers, or pier operators are used as sources of surface observations for the environmental data bases. The implementation of the SWORD system at the Coast Guard Light Ships stations (about 15 stations) would provide additional environmental data. Also, the planned National Data Buoy system would provide time series data for a 600 mile grid for deep ocean waters and a 100 to 150 mile grid within 400 miles of North America.

Climatological Atlases

There is a need for greater detail in atlases for the continental shelf areas and the Great Lakes area. Position accuracy of one mile is desirable and is readily achievable with present Loran "A" coverage on the continental shelves. However, the present WMO code limits accuracy to 0.1 degree, or a maximum of six miles.

Wave and Swell Charts

The unfulfilled need is for additional data collection coverage on the continental shelves and Great Lakes. CERC is the primary Federal producer of wave and swell data products for the U.S. continental shelf. Production is limited to selected coverage and is in support of local Corps of Engineers projects. The main Federal holdings of visually observed sea, swell, and wave data are at EDS and NAVOCEANO (deep water region), and CERC for measured waves in the shallow water region. The FNWC prepares numerical historical wave and swell charts.

Wave and swell charts for the continental shelf cover two different regions, deep water and shallow water. In deep water, wave characteristics are not a function of depth. In shallow waters (depth less than length of wave up to 300 feet) the height, length, and period vary with depth, and wave direction is modified by bottom topography. The position, depth, and bathymetry of the immediate vicinity of the observation site have to be accurately known for the observations. The present WMO format limits position entries to 0.1 degree (a maximum of 6 miles). This is inadequate for recording shallow water wave observations. The additional data requirements, especially position accuracy and bathymetry, limit the useful observations of waves in shallow waters to fixed position platforms and shore stations.

Accurate wave data are needed both for the evaluation and adjustment of visual observations and for use in spectral analysis. Present sources for accurate wave data are the Ocean Station Vessels (10 to 15 stations), Light Ships (8 to 12 stations), several instrumented towers, coastal wave gages and wave data from special scientific and engineering studies (e.g., Sealab II).

Sea Surface Temperature Atlases and Charts

The unfulfilled needs are for bimonthly or weekly sea surface temperature charts with smaller (1° to 2°F) isotherm intervals and larger scale. For established fishery areas chart scales of 1:100,000 to 1:1,000,000 are required, while for tropical and subtropical areas the desired scale is 1:500,000 to 1:5,000,000.

Sea surface temperature observation data bases are held by NAVOCEANO, the Environmental Data Service, Bureau of Commercial Fisheries, Bureau of Sport Fisheries and Wildlife, Coast and Geodetic Survey, National Oceanographic Data Center (NODC), Lake Survey, National Meteorological Center, National Environmental Satellite Center and Fleet Numerical Weather Central.

Surface Current Charts

The unfulfilled needs are for charts at scales of 1:500,000 to 1:1,000,000 for the continental shelf. In addition, these charts are needed for Search and Rescue use at a scale of 1:250,000.

The major holdings of continental shelf surface current data are in the data bases of the Coast and Geodetic Survey (tidal currents), the Coastal Engineering Research Center (longshore currents), and the Naval Oceanographic Office (set and drift observations). Most of the surface currents data from scientific and water pollution studies have not been included in any of the above surface current data bases. The major holdings of deep sea surface current data are at NAVOCEANO. Numerical historical surface current charts are prepared by the FNWC from synoptic analyses of previous years.

Ice Atlases

The unfilled needs are for larger scale and increased coverage for the continental shelf areas and Great Lakes. An adequate Ice Atlas of the North Atlantic has recently been published by the Naval Oceanographic Office.

The Naval Oceanographic Office and the Lake Survey actively acquire ice data, and EDS routinely collects ice observations as part of weather observations. The Lake Survey plans to prepare an Ice Atlas for the Great Lakes. Except for ship observations, the ice data bases at the Lake Survey are hard copy files. The Naval Oceanographic Office has three-card decks of ice data in addition to hard copy holdings. The continental shelf data bases of NAVOCEANO, EDS, and the Coast Guard should be consolidated.

Water Column Properties Data Products

The unfulfilled needs in these products are for stratification layer charts for the Great Lakes and thermocline depth and sound velocity atlases for the U. S. continental shelves and the Great Lakes. No attempt has been made to provide adequate geographic coverage; however, the Coast and Geodetic Survey has proposed making additional water column observations and preparing the needed water column properties atlases.

Water properties data for the Great Lakes are limited to Lake Erie, Lake Huron and the eastern half of Lake Superior. Within several years the Lake Survey will complete data collection for Lake Superior and Lake Ontario, and plans to prepare the water column properties products for the Great Lakes.

Pilot Charts

Pilot charts are not available for the U. S. continental shelves and the Great Lakes. If climatological atlases, wave and swell charts, surface current charts, and ice charts are prepared for the U. S. continental shelves and the Great Lakes, Pilot Charts at scales of 1:1,000,000 to 1:5,000,000 could be prepared as by-products.

Marine Topographic Charts

Bathymetric Maps

The unfulfilled needs for bathymetric maps are additional coverage at larger scales. The Coast and Geodetic Survey compiles only four 1:250,000 scale maps per year, which is only five percent of the total planned coverage. Present data base holdings are inadequate for preparing bathymetric maps. Seventy ship-years are required for adequate coverage, while only two ship-years of surveying per year are planned.

The Coast and Geodetic Survey prepares bathymetric maps without computer assistance. The hydrographic smooth sheets are hand-contoured. The contours are traced and photographically reduced to the collection sheet scale and "random" tracklines are added to the collection sheet where needed. The tracklines are adjusted for the best crossings. Tracklines with accurate navigation control are used for the adjustment. The additional contours are added based on the interpretation of the soundings by cartographers.

The Coast and Geodetic Survey plans to digitize present data holdings (estimated 60 million soundings). Since 1966, all soundings obtained by the Coast and Geodetic Survey have been digitized during the survey. Collection sheets are computer plotted and preliminary contouring is performed. Until survey data are adequate, the soundings will have to be interpreted and contours adjusted.

The Naval Oceanographic Office produces approximately 25 bottom contour (bathymetric) charts per year (2.5 percent of total planned coverage area). The procedure is similar to that of the Coast and Geodetic Survey except that the bathymetric data are partly digitized and the collection sheets are partly computer plotted. Since the line spacing is inadequate and the "random" tracks are of highly variable quality, track adjusting, sounding interpretation and hand contouring are required. A majority of the soundings are from surveys rather than "random" tracks. However, less than ten percent of the ocean bottom has been surveyed. The data backlog totals 36 million soundings.

Few of the presently available ships of opportunity are used for obtaining "random" track data. The Naval Oceanographic Office receives only 1.5 million miles per year of random track data from all sources. These data are received from Navy ships, Federally owned or financed oceanographic vessels, merchant vessels, foreign hydrographic offices, the International Hydrographic Bureau, foreign and domestic cable companies, and oil companies. The annual track miles by the Federally owned or financed oceanographic vessels alone is estimated to be 1.5 to 3 million. Additional data collection could be obtained by

expanding and upgrading the contributions from federally owned or financed oceanographic vessels and Naval ships. "Random" track data from these ships can be upgraded to survey accuracy with little interference with oceanographic research and Naval operations. Oil companies have an estimated 2.4 million miles of offshore survey data for the U.S. continental shelves, and are presently surveying the U.S. continental shelf at a rate of 400,000 miles per year.

Hydrographic Smooth Sheets

The unfulfilled needs are for additional coverage, and for resurveying of areas inadequately covered. The Naval Oceanographic Office and Coast and Geodetic Survey ships produce digital recordings of surveys. The digital records are computer processed and preliminary plots made at shore facilities. The preliminary plot is reviewed and compared with the boat sheet. Corrections are made and the final smooth sheet is computer plotted. Several survey ships of the Naval Oceanographic Office and Coast and Geodetic Survey have on-board plotters. Smooth sheets can be prepared on board these ships. The Lake Survey uses manual plotting techniques.

At the present time the Coast and Geodetic Survey manually records and later digitizes the data. The Coast and Geodetic Survey plans to fully automate the survey vessels in order to produce an on-line plot of the boat sheet. The survey data will be processed for sounding corrections and position corrections, and a preliminary smooth plot will be prepared when not surveying. The final smooth plot will be prepared ashore. Implementation of these plans will reduce the survey watch manpower requirement from five to two. This reduction in manpower requirements will reduce hydrographic survey sheet costs. The cost of the data collection and preparation is in the range of $30,000 to $60,000 for a

hydrographic survey sheet. Presently, manpower costs are about one-half to three-fourths of this cost. The Naval Oceanographic Office plans are similar to the Coast and Geodetic Surveys plans. In addition NAVOCEANO plans to correct for tides in real time.

Nautical Charts

The unfulfilled needs are for additional contours, inclusion of military features indication of source data age, and simplification of the chart correction policies. Chart compilation, chart maintenance and chart correction are the major nautical chart activities.

The Naval Oceanographic Office presently compiles about 150 nautical charts per year. The Coast and Geodetic Survey compiles about seven new charts per year. Six of these are small craft charts. The Lake Survey compiles about two navigation charts per year; one of these is usually an atlas of small craft charts. Chart compilation consists of the selection and formatting of the data to be presented. The data used are retrieved from data products including hydrographic surveys, geodetic control surveys, photogrammetric manuscripts, special surveys (harbor and channel surveys by state and local agencies and the Corps of Engineers), topographic sheets, charts of areas made by other nations, coast pilots, light lists, sailing directions, and notices to mariners.

Except for recent naval and Coast and Geodetic Survey hydrographic surveys, geodetic control surveys, and special surveys from four Corps of Engineers offices, the data used in the data products are not presently available in digitized, computer compatible format. The Coast and Geodetic Survey is considering plans to digitize both soundings and cartographic data (e.g., aids to navigation, cultural features, topographic features and shoreline features) and to establish an automated source document retrieval system.

Chart maintenance consists of the revision of continental charts to include changes in aids to navigation, changes in channel conditions, indication of new obstructions and removal of obstructions, and indications of new danger areas (e.g., shoals). The Naval Oceanographic Office has printings of revised editions and new editions of 2400 nautical charts per year (about 40 percent of the charts on issue). The Coast and Geodetic Survey has printings of navigation charts for 450 nautical charts per year (about 60 percent of the charts on issue). The Lake Survey has printings for about 50 navigation charts per year (about 33 percent of the charts on issue). All charting agencies use the chart standards to record both changes and the source documents for the changes. These entries are continuously added to the chart standards. The Naval Oceanographic Office makes about 39,000 entries per year. The chart standard is used to revise the nautical chart reproduction plates, which are then used for printings. The Coast and Geodetic Survey, Aeronautical Chart Division, is presently experimenting with the use of CRT displays in chart maintenance.

All the chart agencies, except the C&GS, hand correct nautical charts to conform with important changes in the weekly Notice to Mariners. The Naval Oceanographic Office employs 78 people to make about 50 million corrections per year. A silk screen process is used for correcting large batches of charts. The development of automated aids to navigation, obstructions, and channel depths data bases, with rapid update and retrieval capabilities, would reduce hand processing costs.

The Naval Oceanographic Office has initiated the HO-BC (Hydrographic Office Bathymetric Chart) series of charts which combine the navigational features of nautical charts and the extensive contours of bathymetric charts. This series adequately fills the need for more contours.

Navigation Notices

The unfulfilled needs are for more timely issuance of notices and for clarification of the chart correction policy. The Naval Oceanographic Office prepares the Notice to Mariners. The sources of the notices are foreign notices to mariners from 57 countries (52 percent), the U.S. Coast Guard in the form of Local Notice to Mariners (25 percent), Coast and Geodetic Survey charting activities (13 percent) and Naval Oceanographic Office charting activities (10 percent).* The foreign notices to mariners are translated by the Naval Oceanographic Office. The translated foreign notices to mariners and the notices in Local Notice to Mariners are reformatted for inclusion in the Notice to Mariners. The Naval Oceanographic Office and Coast and Geodetic Survey inputs are hand carried, while other inputs are transmitted by mail. The Naval Oceanographic Office is implementing a plan to standardize wording, reduce the length of each notice, and automate the composition.

The majority of the notices are for aids to navigation: there are 43,500 aids to navigation in U.S. waters alone. A computer compatible aids to navigation data base with a rapid update capability and the standardization of format for all navigation notices (domestic and foreign) would increase the timeliness of the Notice to Mariners.

Geological and Geophysical Products

The U.S. Geological Survey produces geological and some geophysical maps and reports, the ESSA laboratories produce research reports, the Coast and

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*Notice to Mariners System Design, PRC R-1179, p. 18.

Geodetic Survey produces principally magnetic and gravity anomaly maps, and NAVOCEANO produces atlases and bottom sediment charts. The USGS and ESSA laboratories tend to rely on the sample data they collect, with only limited use of sample data collected by other agencies. By contrast, NAVOCEANO's atlas program requires the compilation of all data.

The U. S. Geological Survey's oceanographic activities are centered in the Geologic Division's Marine Geology Program Atlantic Continental Shelf Project located at WHOI. Although not Washington-based, the geological and geophysical products and services provided by this USGS/WHOI project serve a broad user community. Virtually all of the USGS field programs are operated from regional centers rather than from Washington headquarters. As a result, data processing functions are strongly program oriented and are commonly associated with a particular regional center. Thus, the data base for the Atlantic Shelf Project is located at Woods Hole (not Washington) and the computer is located at Woods Hole (not the Survey's computer in Washington). With the exception of such data bases as the USGS/WHOI offshore sediment sample data file, the stream discharge-water quality data of the Survey's Waters Resources Division, the Topographic Division's various standardized data procedures in the preparation of topographic maps, and the statistical data of the Conservation Division, the U. S. Geological Survey program data consist primarily of that obtained by individuals or small teams carrying out field research of a highly varied nature. The data, data bases, and data processing procedures used are somewhat informal and highly variable in scope, format, content, etc., and are difficult to generalize. Nevertheless, the USGS/WHOI program is considered a representative example.

The primary objective of the USGS Marine Geology Program is the preparation of offshore geological maps (and associated interpretative reports) at three principal scales:

- Regional Reconnaissance (1:1,000,000 or smaller) which will cover, for example, the entire Atlantic continental shelf on a few sheets.
- Intermediate Scale (1:350,000) which will delineate mineral resource areas and geologic hazards (e.g., potential submarine landlides).
- Detailed scale (1:63,360), "inch-to-the-mile" sheets, presenting:
  - engineering geologic information on offshore construction sites, and
  - detailed studies of specific mineral deposits, geologic hazards, or other special topics.

The data processing operation of the Marine Geology Program for an offshore survey project (e.g., for the Gulf of Maine) typically would consist of the following steps:

1. Design of sampling program
2. Selection of sampling equipment
3. Field collection of samples
4. Preservation, labeling, cataloging, storing of samples
5. Preliminary sample description, tabulation in data file, and selection for analysis
6. Various physical and chemical laboratory analyses

7. Tabulation or compilation of analytical results in data file
8. Statistical analysis of physical and chemical data
9. Interpretation of analytical results
10. Report preparation
11. Report processing

Of these eleven steps, only steps 4, 5, 7 and 8 are truly data processing in the strict usage of the term.

Funded at a level of approximately $1.2 million for FY 1966 through 1970 and at a somewhat lower level for the three preceding years, the program has concentrated primarily on the Atlantic continental shelf, and has produced six professional papers, five regional reconnaissance map sheets (of which two are for the Gulf of Mexico), and a series of shorter reports and publications. An intermediate-scale map of the Gulf of Maine is well underway and, at the present level of funding, a regional set of these maps should be completed in four to five years.

There are three or four USGS professional scientists working cooperatively with about the same number at WHOI on the Atlantic Shelf Program. They have collected some 3000 samples, which have been analyzed in varying degrees of detail. Between 50 and 75 percent of the project operating budget is spent on sample analysis. Expenditures on data processing amount to only $25,000 to $30,000 annually. Analytic results are (or will shortly be) added to the basic data file[1] which lists the samples. The program receives about 15 to 20 requests per year for use of data, primarily from university researchers. A split of all samples is sent to the Smithsonian Oceanographic Sorting Center and a data file duplicate magnetic tape is held by NODC.

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[1]Wood's Hole Oceanographic Institution Reference 66-8, Continental Margin Program Data File, Vol. 1: Sample collection data (with supplements),

Because of the USGS's extremely high standards regarding the quality and format of its various publications, the time formerly required for a major manuscript or map to pass through the editorial review process was not uncommonly two years or more. Even the editorial review of lesser manuscripts was extremely slow. In recent years, however, the Survey has streamlined the system so that such delays have been reduced. For example, typical editorial review and report processing times are now as follows:

Circulars	30-45 days
Bulletins	4-12 mos.
Professional Papers	1- 2 years
Geological Quadrangle Maps . . .	12-15 mos.
Miscellaneous Investigations Maps .	12-15 mos.

The principal unfulfilled needs regarding geological and geophysical data products and data are;

- more comprehensive coverage of the U.S. continental shelf by intermediate scale geological and geophysical maps and reports;
- a master indexing of geological samples, which specify sample location, composition, status of analysis, etc; and
- an inventory or directory of marine geologic studies currently underway, including location, organization, and equipment used.

The already established (and published) USGS/WHOI Data File constitutes an excellent contribution to the needed Master Index of geological samples. The NAVOCEANO sediment sample file, although less detailed, would be another valuable contribution to the Master Index. A major effort, however, is needed to bring such an index into existence and to keep it current.

More comprehensive geographical coverage requires an accelerated field survey program, which means commitment of additional funds. Although the benefits from increased spending for offshore geological and geophysical programs must be weighed against benefits to be derived from other offshore programs, the very small dollar level of funding to date for geological-geophysical programs seems strikingly disproportionate when one considers the very large dollar revenues brought in by offshore oil royalties and bonuses.

Ocean Engineering Products

These products consist primarily of a wide variety of engineering reports which with supporting tables and drawings, summarize the results of a given engineering program. They include:

1. Definition of mission
2. Definition of capabilities required
3. Development of specifications
4. Preliminary design and cost analysis
5. Detailed design
6. Prototype fabrication, assembly, and testing
7. Operations, maintenance, and repair

Ocean engineering products are generated by at least 52 Federal agency facilities working in such fields as ship and platform engineering, ocean systems engineering, undersea operations, salvage engineering, coastal engineering, instrumentation and materials engineering, and the engineering activities concerned with the development of equipment for fishing and fisheries: search, detection, harvesting processing, vessels, etc.

The variety and type of ocean engineering products (and the data processing associated with their generation) depend on whether the activities involved are: (1) planning-design-construction activities, or (2) operational activities.

They also vary as a function of whether the data and/or data product is non-environmental (strength of materials, corrosion, etc.), or environmental in character. For example, the nonenvironmental data products developed by and/or required by ocean engineers working on a detailed design engineering re rt will differ substantially from those involved in a report summarizing time-series observations of oceanic parameters (environmental).

The Navy program in ocean engineering was at a level of $100 million in FY 1969, and funding of $150 million is anticipated in FY 1970. In 1969, the oil industry will spend some $2.2 billion on offshore oil exploration, drilling, development, and production; an estimated 20 to 25 percent of this will be spent in the various fields of ocean engineering, again mostly nonenvironmental in character. In view of the enormous sums of money involved, it is difficult to understand why there has been so little exchange of engineering data between the Federal government and private industry.

Developments that would help satisfy the need for ocean engineering data and products are the following:

- The designation of NODC as a ocean engineering data referral center. The implementation of this recommendation will reduce the further proliferation of data centers and will result in the centralization of nondefense ocean data reference services in one location. It should be noted that NODC would not store all raw oceanographic data. Rather, it would maintain a data base of references to ocean engineering reports, bibliographies and sources of ocean engineering data.
- Continued development of the Navy Ocean Engineering Bibliographic system and an abstract and data retrieval service to be applied to the Deep

Ocean Technology (DOT) program with expansion to all Navy ocean engineering as a future goal;

- Compilation and preparation of reports by the Navy (assisted by CERC and USGS) which would contain ocean engineering formulae, coefficients, constants, and pertinent tables not available from commercial sources.

Fishery Statistics Reports

The lack of completeness of data collection coverage and timeliness of dissemination of the present Fishery Statistics Reports produced by the BCF Branch of Statistics are the two major factors that limit the usefulness of this publication series to both industry and government.

The current procedure employed in gathering statistical data on U.S. domestic fisheries consists of both statistical surveys of the fisheries and fishing industries of the various sections of the U.S., and local and special surveys of selected fisheries and fishing ports. In the case of the former, BCF field representatives visit the individual fishing localities of the various states to collect statistics on the volume of the catch of fish and shellfish, employment, quantity of fishing gear, number and classification of fishing craft and the value of processed fishery products. In the collection of data on operating units (vessels, crew, gear) BCF personnel use a set of prepunched vessel cards supplied from the Bureau of Customs. These cards indicate the name, official number, tonnage, etc. In addition to these data BCF obtains through interviews information on the number of crewmen and number and types of gear used on the vessel. The completed cards are then forwarded to the Branch of Statistics office in Washington, D.C., for machine processing and tabulation.

At the present time, data on over 96 percent of the U.S. domestic catch are available from summaries of monthly landings bulletins and other current records assembled by the Bureau or the various States. If complete catch data are not available from central sources, wholesale dealers and manufacturers of fishery products are visited to obtain the data.

Local and special surveys of various fisheries are conducted by BCF personnel assigned to the principal fishing ports. They obtain figures on the quantity and value of fish landed daily by fishery craft, fishing effort, gear, and the areas fished. Most of the information is obtained from personal interviews with vessel skippers and recorded on log forms supplied for this purpose. BCF's Division of Biological Research and Branch of Market News cooperate in the collection of these data. In some cases, for example in the Gulf of Mexico shrimp fishery, various State fishery agencies also cooperate in the collection of local and special fishery survey data.

Transmission of the fishery statistics to the Branch of Statistics in Washington, D.C., is by mail. Incoming fisheries statistics are received in various formats ranging from tabulated data in publications to copies of data on magnetic tape. At the present time five to seven personnel, operating on a budget of $90,000, are responsible for the final tabulation and processing of monthly and annual summaries of these data. Automatic data processing equipment used to assist in this task consists mainly of basic keypunch and tabulation machines. Computer time is available on the U.S. Geological Survey's IBM 360/65 computer on a low priority basis. At the present time, the use of a commercial computer for such tasks as preparation of statistical reports is being seriously explored.

It is usually three or four months after the close of an individual month before the monthly summaries of catch, value, etc., are available from the field offices and cooperating State agencies. The compilation and publication of annual statistics from the individual States in the annual fisheries statistical digest is currently lagging two years behind.

Areas for improvement in the production of the current Fishery Products Reports include establishing new data collection series such as:

- statistics on the involvement of U.S. companies in international fish production, processing and marketing;

- statistics on foreign fish production processing and marketing;

- statistics of U.S. and foreign fisheries regarding incomes derived from fishing, capital investments in vessels, costs of obtaining capital and costs of fishing operations.

Another area for imp ovement is the overhaul of the current reporting system so that monthly estimates of total U.S. landing and average prices of fish, along with other information such as holdings, shipments and imports, can be made available within a few days after the end of the month.

The development of a uniform and expanded cooperative Federal-State statistical collection system is perhaps one of the most critical areas for improvement of the present statistical system. At the present time BCF provides about 75 percent of the total effort, yet has very little control over formats, completeness or timeliness of data collection or transmission.

In order to achieve completeness and timeliness of Fishery Products Reports, it will be necessary to expand the limited automatic data processing capabilities of the BCF Branch of Statistics. In developing a program for expanded cooperative fishery statistics collection, existing agreements between various States and BCF should not be overlooked. The Aquatic Living Resources Program of BCF has developed and partially implemented plans for a nationwide computer system designed to serve all aspects of BCF operations from research to fishery statistics. The initial phase of the program involves the installation of a small computer terminal (IBM 1130, or its equivalent) at its laboratories in Beaufort, North Carolina; Seattle, Washington; and Ann Arbor, Michigan, with tie-lines to the U.S. Geological Survey's computer center in Washington, D.C. Total cost per month for the initial program is estimated to be on the order of $9,000.

Fishery Resource Atlases

Information and data useful for the production of these atlases are currently being collected by BCF Biological Laboratories as part of their research programs; however, no defined programs exist at these laboratories for the utilization of data in this manner. In contrast, the BCF Exploratory Fishing and Gear Research Bases in Seattle, Washington, and Pascagoula, Mississippi have been using automated systems for the storage and retrieval of large volumes of biological and physical data collected during the course of exploratory fishing. For example, files of the BCF Gear Base in Pascagoula contain some 16,000 station cards with 35 coded items of information, and roughly 200,000 species cards with 29 coded items. These systems can provide statistics on the weight and catch per hour of each species and group encountered by statistical area, and the relative percentage composition of the catches by area and depth. These types of data are a basic requirement in defining the distribution, availability, and relative importance of various fisheries resources. Atlases of foodfish trawl resources of the east coast of the U.S. and the white, brown, and pink shrimp fishery in the Gulf of Mexico are currently in production at the BCF Base in Pascagoula.

The major improvement required in order to produce fishery resource atlases of value to the fishing community would be centralization of the effort on a regional basis for the purpose of developing computer techniques for the analyses of existing data. In addition, a comprehensive search of the existing literature should be made to obtain additional information for inclusion in analyses and atlases. This type of program could also provide important background information for both new and expanded exploratory fishing operations in new areas. Also, gaps in data coverage, and programs to fill them, can be ascertained.

The format of the fishery resource atlases might be improved by using loose-leaf existing nautical charts with appropriate transparent overlays for the purpose of having fishermen note on the charts additional information regarding such factors as bottom conditions, currents, fish presence and other related data. The annotated overlays could be returned annually by the fishermen to BCF for updating and production of new charts. Both the original overlay and copy of the improved chart would be returned to cooperating fishermen.

Sportfishing Atlases

With the completion of the Sportfishing Atlases for the Atlantic and Gulf Coasts now in preparation at the Bureau of Sport Fisheries and Wildlife Marine Laboratories at Sandy Hook, New Jersey, and Panama City, Florida, coverage of the U.S. continental coasts will be complete. In order to ensure maximum use of these atlases, they should be widely distributed and their availability made known to the user community. Perhaps the most effective means of achieving this goal would be to make copies available to operators of sporting goods and fishing supplies outlets. In this manner, novices as well as seasoned fishermen would have an equal opportunity to purchase copies of the atlases.

Catch data are required in order that the relationship between the catch of sport and commercial fishermen fishing the same species can be determined for the purpose of allocating catch quotas on a more equitable basis. Such data is of particular value in the case where the fishery in questions is in danger of depletion due to overfishing. The use of pre-punched cards issued to fishermen at the time of licensing, such as those used in the States of Oregon and Washington, is a possibility for gathering the required data.

RECOMMENDED NEW PRODUCTS AND SERVICE OPERATIONS

Derivation of Recommendations

The inadequacies of existing products discussed in the previous sections were identified through an analysis of user requirements. During this analysis additional needs were identified which cannot be readily met through improvements or modifications of existing products. These needs require the preparation of new products, utilizing existing data acquisition systems, data bases, and processing and analysis capabilities, supplemented in most cases by the acquisition of new or additional data, the establishment of several new data bases, and the development and utilization of new methods of analysis and product preparation. There is also a need to consolidate existing data bases, as this would lead to new as well as better products.

Most of these recommended new products are descriptive in nature, though several forecasting products are included. The emphasis in these new products is on dynamic oceanography and the air/sea interface. Some of these recommended products will receive widespread usage by diverse communities, while several have quite specific and limited application. Those in the latter category are of a fundamental nature. The availability of these specialized products could lead to wider applications in the future in areas in which there is no current demand.

The following descriptions of these recommended new products are of a general nature. The specification of coverage, detail, schedules, etc., will require detailed analysis for each product, at such time as the product may be considered for implementation. Certain of the recommended new products have been included in the TDP. Sufficient information is available concerning these products to specify the resources required for their development and implementation. In the case of other products, although insufficient information is available to accurately assess the resources necessary for their development, it is recommended that they be considered for development and implementation. In the case of products included in the TDP, recommended lead and contributing agencies are indicated.

New Products Provided in the Technical Development Plan

Subsurface Current Atlases (NAVOCEANO)

This product is currently of interest for its potential value in undersea military operations. It would also be of value in preparing subsurface current forecasts, and may have additional applications. Current locations, distributions, velocities, and directions, and related pertinent information, would be included. These data would be acquired principally from ocean stations.

Mean Sea Level Atlases (C&GS)

Mean Sea Level Atlases would provide a supplement to tide products. For each area covered the mean results of astronomical tides, meteorological effects, bottom topography, and shoreline configuration would be indicated. Deep ocean tides might also be included. This product, used in conjunction with tide tables, would provide more directly useful information for various user communities.

Coastal Atlases (C&GS lead agency; contributions by EDS)

This product would include salinity, temperature, depth and other subsurface data; surface data including temperature, ice, wave period, direction, and height; and climatic data. Selected coastal areas would be included. Some of the required data exists, particularly in NAVOCEANO classified files; however, more may be required. Also included would be information for the rapidly expanding recreation community. This would include descriptions of beach and shore facilities; piers and marinas; sportfishing information; swimming, sunbathing, diving, and surfing information; and specific shoreline features which have high recreational use. The required information is currently available; however, updating of the guides will be required on a periodic basis. The Coast and Geodetic Survey provides some of this information with its small craft charts.

The major use of these atlases would be by those user communities with operations in the coastal zone, particularly industrial operations, ocean engineering, resource management and planning and recreation. They would also be of direct value to the environmental forecasting community.

Great Lakes Climatological Atlases (Lake Survey)

These atlases would be similar in nature to the previous product, but would be produced by a different responsible agency. A major part of the data required are currently available.

Ocean Engineering Reports (NAVOCEANO lead agency with contributions by CERC and USGS)

These reports would include a diversity of reports concerned with the various Federal interests in ocean engineering subjects, including coastal engineering, deep submersible engineering, and including instrumentation and materials information. The information contained in these reports would consist of unclassified and "sanitized" versions where necessary. The objective is to increase the availability of ocean engineering data for use by the general engineering community.

Bathymetric Maps (Lake Survey)

This is an existing product; however, it would be a new activity for the Lake Survey.

Wave and Swell Atlases and Charts (Lake Survey)

This is an existing product as above, but new for the agency.

Other New Products

Surface Water Mass Transport Atlases

This display and hard copy product would describe the mean mass transport of surface waters in designated areas, as the result of surface currents and other factors. The major value of the display would be the presentation of data which could be utilized in analyses of mass and energy balance in ocean systems. The data are available, but not necessarily complete.

Salinity Atlases

Salinity is a fundamental variable in oceanographic analyses. Extensive data and some charts exist. A compute graphics display and hard copy presentation of these data would be of value in general oceanographic studies, in the study and preparation of sea air interaction products, mixing studies, etc.; and would have practical application in submersible operations and fishery activities.

Bottom Temperature Atlases

Bottom temperatures are of particular interest to fisheries operations and fishery resource management activities. Commercial and sportfish, shellfish, and crustaceans have specific requirements for environmental temperatures, and many species migrate with changing temperatures. The atlases would be prepared for selected areas in which major bottom fishery activiti exist. Some data exist but additional input would be required.

Water Quality (Pollution) Maps and Atlases

These products would be prepared for coastal waters, bays, estuaries, harbors, and marinas, and for the Great Lakes. These waters are defined as interstate waters, and therefore under the direct jurisdiction of the Federal Water Pollution Control Agency. Water quality control activities in these waters is

the direct responsibility of State, regional, and local agencies. However, these activities must conform to FWPCA requirements. The products would contain past and present data on water quality; related biological (ecological) information; current, upwelling, and climatic data relating to dispersion and assimilation of wastes; location of outfalls and descriptions of past and present effluent volumes and characteristics; description of other sources of pollutants, including industrial operations, shipping, boating, flood runoff, etc.; and current water quality objectives and Federal, State, and local regulations designed to meet these objectives.

A series of products would be prepared for designated sections of the coasts and Great Lakes with priorities in relation to the existence or threatened existence of pollution. Since much of the data is collected by non-Federal agencies, cooperative efforts will be required to acquire and analyze existing data, and to collect additional data. The products would be used by the resource planning and management community, effluent dischargers, the recreation community, the fishing community, and the public at large.

Sea-Air Energy Exchange Forecasts

This new product would help to bridge the energy continuum at the sea surface. The major use of the forecasts would be in their application to weather forecasting, particularly extended range forecasting; however, those users concerned with energy relationships in the upper layer of the oceans might also make practical use of the product.

Input data required for the forecasts would include thermal structures of the subject oceanic area from the bottom of the thermocline to the surface, thermal structure of the overlying atmosphere, associated current and wind data, other meteorological data, and sea state data. These data would be required on a synoptic (or semi-synoptic) basis; however, the frequency of data collection remains to be specified. The practical development of a data buoy system will

probably make possible the collection of these data. Satellite IR data, for sea surface temperature, would have only limited value. Radar scatterometer data, for sea state observations, may be more pertinent. The existing data collection system is not adequate for the implementation of these forecasts.

Subsurface Current Forecasts

Subsurface current forecasts would be of direct value in undersea operations, which are presently limited to military activities. These forecasts would serve a purpose similar to upper air wind forecasts in aviation operations. Additional future applications of this product are possible as an input to other forecasting products or in future nonmilitary operations in deep waters.

The data required for these forecasts would come from data buoys, ocean station vessels and submersibles. Data buoys will be too widely dispersed to provide the detail required. Current velocity and direction, density, and temperatures may be included in the required data, collected on a synoptic or semi-synoptic basis.

Upwelling Forecasts

The prediction of the location, extent, and intensity of upwelling is of particular interest to the fisheries community, since upwelling has a major effect on the ecology by modifying the thermal regime and increasing the mixing and availability of nutrients. Accurate forecasts could result in an improvement in the catch/effort ratio through the direction of commercial fleets to areas of maximum probable fishing success. These forecasts might also prove to be of value (on a seasonal basis) to those agencies responsible for coastal water quality control. Mixing resulting from upwelling increases the density of dissolved and particulate solids in the surface waters, and reduces the dissolved oxygen levels at the surface. These parameters are basic in water quality determinations. Algal blooms, (notably "red tides") are commonly

associated with upwelling, since nutrients are made available in the surface waters. Upwelling forecasts might, therefore, be of use in the regulation of waste discharges into the environment, and in predicting the persistence and effects of accidental discharges, such as oil spills.

Extensive information on coastal areas of upwelling exists; however, the extent and intensity varies, and current and weather conditions can produce upwelling in areas where it does not normally occur. Input data for the forecasts would include current data, surface wind data, and temperature data, and forecasts of these causative factors. The forecasts would be produced for selected, limited areas of interest.

Sea Surface Water Level Forecasts

Tide tables currently being produced are based mainly on astronomical causes and modifications resulting from coastal configuration and bathymetry. The predictions in these tables are extremely useful, but are inadequate for some purposes. Observed tides are the result of meteorological, as well as astronomical effects. There is a need, therefore, for relatively short-term predictions of water levels based on both astronomical data and meteorological conditions. These predictions would supplement the existing tide products, and would be used in those situations where accurate water level forecasts are required; including shore and coastal industrial engineering activities, port and harbor operations, military operations, and fishing and recreation activities.

Input data for these forecasts would include tide tables, surface weather in offshore areas, weather forecasts for these offshore areas, nearshore bottom topography for the forecast area, and the coastline configuration (including resonance period information) for the forecast area. These input data are currently available for most areas of interest, and techniques exist for preparing the forecasts. Cost/benefit analyses and refinement of forecasting techniques are required.

Inland Lakes Ice Forecasts

This is an existing product, pertinent to the Great Lakes and other inland waterways, which requires a major increase in emphasis. The current product is inadequate relative to the requirements of the users. The user communities include merchant shipping, industrial operations, recreation, and the public at large. Improved forecasts would have a significant economic impact on the activities of these users.

Sea-Air Energy Exchange Atlases

This product would supplement existing and future marine climatological and oceanographic atlases, and would include statistical and summary presentations of the exchange of energy across the sea-air phase interface. The data would pertain to the upper level of the ocean above the mixing layer, the phase interface, and the overlying atmosphere.

This product would be used principally by the environmental forecasting community in the preparation of weather and oceanographic forecasts, and the recommended Sea-Air Energy Exchange Forecast. The data would be acquired from that used to produce the latter product, and other sources.

DATA BASES

A complete list of data base improvements and new data base development requirements is presented in Table VII-1 of Chapter VII.

V. REQUIREMENTS AND IMPACT OF TECHNOLOGICAL CHANGE ON MARINE DATA MANAGEMENT

This chapter deals principally with the hardware and software required for marine data management, from data collection to the dissemination of products.

RECOMMENDATIONS WHICH APPLY TO SEVERAL AGENCIES

Before discussing individual agency needs, it is well to discuss certain recommendations which apply to more than one agency.

RECOMMENDATIONS FOR SHIPBOARD COMPUTERS

The installation of process control computers aboard ships has far greater implications than the manipulation of data and the production of interim products which is detailed in the following sections. To a certain extent, such a machine can control a survey ship, relieving personnel of many bookkeeping chores thus having an impact on the composition of the crew. In principle, if navigational information and sensor readings were input to the computer, a limited oceanic survey could be carried out with little human intervention other than standing watch against collisions. Such automated surveys may very well be tried on an experimental basis during the coming decade, but the recommendations found in this report for shipboard computers do not depend on the full utilization of computers.

In the past few years, laboratory computers have gone to sea with a success which is surprising to computer and marine experts alike. The problems associated with ship motions, such as torque in disk equipment due to rolling, and vibration problems, have been less serious than anticipated. Although power outages and breakdowns in air conditioning systems do cause problems, they are usually not any more serious than those encountered in shore-based operations. The most serious problem is that of finding personnel to perform maintenance,

programming, and machine operator functions at sea. To save costs, it is natural to seek all three capabilities in a single individual, which compounds the difficulty. One solution to this problem would be for agencies acquiring shipboard computers on a timephased basis to send individual engineers, operators, and programmers to sea with the first computers and train them in each other's jobs, with appropriate salary incentives.

RECOMMENDATIONS FOR DIGITIZATION AT SEA

Recommendations for digitization at sea of data as it is collected do not imply that no analog record should be kept. Although it is possible to construct sensors so that no analog record is conveniently available, "digital instrumentation" as the term is used in this report is assumed to provide a visible analog display and permanent strip chart record. The thrust of recommendations for digital systems is toward reducing the necessity of using analog records except as a backup system.

In digitizing an analog signal, the basic function of the digitizer (machine, human or a mix of these) is to accurately pick a discrete value from a continuum (or more dense discrete set) of measurements in the presence of noise. Digital recording of soundings in high sea states is an example. The return as traced on the usual analog PDR or PGR includes the surface return, noise, the deep scattering layer, and returns from nearby bottom features scanned by the beam as the ship rolls and pitches, as well as the bottom echo. The digital record could recreate the PDR record, noise and all, if this were desirable, simply by recording the time of each return pulse with strength above a sufficiently low threshold. A better choice would be to record the time of the three or four strongest return pulses on an original sounding tape. The original tape would then be input to an editing program which would also accept inputs from human interpretation of a strip chart. The actual editing could be performed at shore-based facilities using graphic display consoles and light pens; or it could be performed on board ship with card inputs. The choice to ping rates and keeping track of what multiple of (say) 400 fathoms is to be added to the depth

is a function which can be performed by the computer as well as by a human standing PDR watch. If the human operator watches over the computer operation (as he must), the combination of man and machine activities will be much superior to either alone.

In summary, it is recognized that good instrumentation and good engineering are needed for the successful performance of digital data functions at sea. It is not, however, considered that any technological breakthroughs are required for implementation of the recommendations related to digital data and computers found in this report.

RECOMMENDATIONS CONCERNING INSTRUMENTATION

Well-established techniques and instrumentation for the measurement of oceanographic parameters are not discussed in this report except in those cases where new, qualitatively superior instrumentation or techniques are likely to become available within the next ten years. Every instrument is, of course, inadequate in some way, and the level of engineering skill which goes into a particular type of instrument varies widely across the spectrum of manufacturers.

Role of the National Oceanographic Instrumentation Center

The newly established National Oceanographic Instrumentation Center (formerly the Naval Oceanographic Instrumentation Center) will continue its valuable function of testing and evaluating instruments acquired by the Center. The Center's reports (fact sheets), which are presently distributed to some 2,000 subscribers within the Federal establishment, have already had considerable positive influence on instrument quality. The calibration and other information given in the fact sheets should be available for all instrumentation used by the agencies discussed in this report, including instrument systems developed by the agencies themselves, for quality control indication. In addition, facts developed from agency experience with instrumentation should

be transmitted to the Instrumentation Center and disseminated to all marine agencies on a regular basis.

The National Oceanographic Instrumentation Center in conjunction with the National Bureau of Standards is the focal point for setting instrument standards, promulgating of international standards, and coordinating the development of general purpose instruments and systems. NOIC should also be authorized to advertise the availability to the general public of instrument face sheets.

Shipboard Wave-Height Sensor

At the present time no well established instrumentation for the measurement of ocean waves from ships exists. Bow-mounted radar and infrared wave sensors are under development. The infrared version is considerably less expensive, and recent tests by NAVOCEANO indicate that it may be equivalent in performance to the radar sensor, the feasibility of which has already been demonstrated.

Neither these instruments nor any other instrument so far developed can give a full description of ocean waves from underway ships. From the standpoint of the seaman, however, the parameter of greatest interest is the sea state. If the infrared wave height sensor turns out to be reliable, so that only directional information need be determined by visual observation, it will be of great service.

Use of Buoys for Measuring Sea State

For sea state determination from buoys, accelerometers should be useful if the response of the buoy to all types of sea conditions can be determined.

Depending on the mooring subsystem finally selected, pressure sensors on a subsurface buoy might be used with or instead of accelerometers. No matter what sensors are used, the system must still be calibrated. One completely satisfactory type of platform exists for measuring deep water waves: the type exemplified by FLIP (Floating Instrument Platform). This platform, essentially a large spar buoy, has a natural heave period of 27 sec, well outside the spectrum of oceanic wind waves and swell, and its response to excitation is well known.[1] The response of buoys and sensors selected for the Coast Guard's National Data Buoy System could be determined using FLIP for calibration.

Besides sea state or more detailed wave measurements, the National Data Buoy System concept offers the opportunity to measure several midoceanic phenomena in a way qualitatively superior to any present method. Present means of measuring oceanic surface currents are by the use of drift bottles, by calculation of current sets (differences between dead reckoning and "actual" position) by navigators, and, more rarely, by the drift of manned platforms in special experiments. Of these present methods, only the last can give detailed information about oceanic currents.

Current meters mounted along a buoy mooring cable to obtain current profiles at the buoy positions as a function of time are within the state of the art. Tsunamis may also be detected by pressure sensors--perhaps with self-contained alarm-triggering systems--mounted on the buoy anchor. Further discussion of problems of buoy instrumentation, as well as buoy systems functions necessary to furnish synoptic meteorological data for the Weather Bureau, will be presented in the section dealing with the U.S. Coast Guard.

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[1] Snodgrass, et al., Phil. Trans. Royal Society of London, 259, 1103 (1963).

Remote Sensing of Oceanographic Parameters

Development of instrumentation for measuring sea state and oceanic skin temperature from aircraft and satellites is proceeding at NASA-Houston (Earth Resources Aircraft Program). The Navy's Spacecraft Oceanography Program and regular use of the weather observation planes has contributed mightily to this effort. Present emphasis in the experimental use of radar scatterometers to measure sea state is on studying fully developed seas, for the purpose of deriving surface wind information. The radar scatterometer, however, could be used to measure sea state whether the sea is fully developed or not, and should also be evaluated for its potential in deriving more detailed descriptions of the ocean's surface, such as swell period and direction. This should certainly be possible from aircraft, and may be possible from satellites as well.[1] In this connection, FLIP would furnish the best possible "ground truth," or control.

Questions of interpretation of oceanic skin temperatures measured by infrared sensing exist. The term "skin temperature" is used here to stress the fact that only the first few millimeters of water are seen by the sensor, and the relation of such measurements to sea surface temperatures obtained by bucket thermometers or STD's at the surface is not well known, depending as it does on detailed thermal equilibrium (or lack of equilibrium) in the first few centimeters beneath the surface. In the presence of spray or high water vapor content, it may be questioned whether the sensor "sees" the water at all. Resolution of such questions of interpretation of bolometric measurements of radiation from the oceans must await further scientific research.

[1] It might be possible to apply the techniques of analysis used by radio astronomers in studying interplanetary scintillations, that is, treating the ocean surface as a phase-changing screen--in this case, in reflection.

Other developments in spacecraft oceanography and related meteorology are exemplified by the experiments flown on the most recent (April 1969) NIMBUS satellite. These include an infrared interferometer spectrometer for sensing the vertical distribution of water vapor, ozone, nitrous oxide and other pollutants, and temperatures. The Satellite Infrared Spectrometer (SIRS) system, the development of which is well advanced, is also on board and will give the vertical atmospheric temperature distribution from the surface to about 80,000 feet along the orbit of the spacecraft. Measurement of the earth's radiation balance (heat budget), important for long range weather prediction, will be carried out with a medium resolution infrared radiometer.

Only such inadequacies as exist in the field of remote sensing from satellites that are exclusively related to storage and retrieval of data and the production and dissemination of products can be constructively addressed in this report. That is to say, although difficulties in spacecraft instrumentation and telemetry exist, they arise from limitations in the state of the art, and not from any inadequacy in data management procedures. Problems related to archival storage and the preparation of products will be treated in the sections dealing with agencies which make use of remotely-sensed data for their products and services.

The use of aircraft to study the air-sea interface and other aspects of oceanography and marine meteorology is well established. For wave measurements, stereoscopic photography has been used in research. This method gives the most complete possible description of the sea surface in a limited area, so detailed, in fact, that contour maps derived from such photography are little more than curiosities. The use of a radar r results in a recorded section of the surface f (x,y,t) beneath the aircraft, where the space and time coordinates are related by the course and speed of the aircraft. Although this relation complicates spectral analysis of the surface, a highly accurate sea state determination can be extracted from such a record. A more direct measurement of sea state is possible using the radar scatterometer.

AGENCIES CONCERNED WITH MAP AND CHART PRODUCTION

The first three agencies to be discussed are the U.S. Naval Oceanographic Office (NAVOCEANO), the ESSA-Coast and Geodetic Survey (C&GS), and the U.S. Lake Survey. In all three agencies, the most stringent demands for hardware and software are made by the large volume of each agency's data bases produced by hydrographic, oceanographic and geophysical surveys. The chartmaking and chart correction functions of these agencies in fact are the dominant or lead functions in each case, so that although the agencies are discussed separately, some points which apply to all three are only fully discussed in one section, to avoid repetition of the same details.

U.S. NAVAL OCEANOGRAPHIC OFFICE (NAVOCEANO)

Priority products of NAVOCEANO are bathymetric maps, nautical charts (often collected from foreign governments), navigation notices (Weekly Notices, Daily Memoranda, and radio broadcasts), magnetic field maps (HO 1700 Series), Pilot Charts and climatological atlases, gravity field maps, sea surface temperature atlases and thermocline depth charts, and the HO 700 atlas series (oceanic currents, physical properties, ice, sea state and swell, marine geology, and sound velocity). NAVOCEANO produces a large volume of classified products, most of which could be sanitized for wider distribution. It is part of the mission of NAVOCEANO to complete the bathymetric survey of the world oceans. It is estimated that half the oceans have been surveyed at approximately five-mile line spacing. This data has been used for the production of about 500 bathymetric maps at scales from 1:500,000 at the equator to 1:350,000 at high latitudes. At the present level of effort, about two and one-half percent of the planned coverage, 500 additional maps, is being accomplished annually, so that completion of the task would require 40 years.

Adding to the survey workload is the necessity of producing 1:75,000 scale coastal charts; these charts exist only for about one-quarter of the world's coastline and as many as 2,000 charts remain to be produced. The Technical Development Plan recommends an increase in this survey work from the present 25 percent geographic coverage to 75 percent by FY 80.

Data Base Volumes

With present techniques, soundings are put into digital form at some point in the cartographic process (onshore). In the future, the survey itself should be able to deliver digital information to shore-based facilities.

The following increase in 10-year digital data volumes is projected:

Soundings	3×10^9 datapoints	3×10^{11} bits[1]
Magnetic Data	700×10^6 datapoints	7×10^{10} bits[1]
Gravity Data	6×10^6 datapoints	6×10^8 bits[1]

Total data base sizes at the end of 10 years are estimated to be:

Soundings	3.7×10^9 datapoints	3.7×10^{11} bits[1]
Magnetic Data	744×10^6 datapoints	7.4×10^{10} bits[1]
Gravity	7.1×10^6 datapoints	7.1×10^8 bits[1]

The data base volume described in the previous paragraph by their bulk dominate NAVOCEANO in-house data bases. Geomagnetic data from aircraft, under the present program of flying aircraft on east-west courses separated by 200 miles, would result in less than 10^6 miles of flight path; and presumably much less than 10^8 usable magnetic field values. An aids-to-navigation file for the entire world could be contained on about 250,000 punched cards or about 2×10^7 characters including blanks. A digital file of all the world's coastline, which is

[1]Assuming 100 bits per binary coded datapoint.

about 150,000 miles excluding French Polynesia[1] and assuming smoothing appropriate for 1:250,000 scale or smaller, would comprise no more than 5×10^7 coordinate pairs (assumes the equivalent of digitizing every .0001 inch from 1:250,000 maps).

BATHYMETRIC MAPS

As stated above, about half the world's oceans have been mapped by NAVOCEANO to date. At the present level of effort (ten ships) the remainder of the world would be mapped in 40 years. Measured against the increasing interest in oceanic resources and in oceanography in general, this time interval appears to be excessive.

The Technical Development Plan recommends an increase of 12 survey ships in the next 10 years in order to increase the bathymetric and nautical chart coverage for scales of 1:75,000 or larger from 25 to 75 percent. The survey ships would also be used for geophysical and oceanography data collection. Shipboard computer systems are recommended for these survey vessels. They should be process control machines of 131,000 character core storage capacity, with plotters, disk drives, three or more tape drives, card inputs, and an analog to digital converter. Part of the function of the shipboard computers and peripheral equipment would be to maintain the survey bathymetric file as it is accumulated; performing corrections for the speed of sound, merging depth with corrected positions as fixes and crosschecks are obtained, and producing boat sheets as sufficient data accumulated. Automated contouring would also be possible, and even though eventually cartographers would have to check and hand-correct the contours, their task would be significantly lightened by the automatically drawn preliminary contours.

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[1] National Council on Marine Resources and Engineering Development Third Report: A Year of Broadened Participation, January 1969.

Magnetic and gravity data can be treated, of course, in the same way as bathymetry data. It is estimated that all soundings and geophysical data for a given survey can be contained on three reels of 800 bytes-per-inch tape.

NAUTICAL CHARTS

At NAVOCEANO, it is envisaged that approximately 80 cartographers in FY 1971 growing to 200 in FY 1980 may be occupied in updating nautical charts and producing charts of foreign coastal waters with scales of 1:75,000 or greater. Seventy-five percent of the world's coastline remains to be so mapped; so about 120,000 miles of coastline would be involved.[1] About 2,000 charts will have to be generated and maintained, in addition to the 600 coastline charts now extant (these are rough estimates based on "smoothed" coasts aligned along the diagonal of one-square meter charts). Each of these charts will include aids-to-navigation file will be a necessity for chart maintenance. If all 2,600 coastline charts are to be updated semi-annually,[2] about 21 updating operations ranging in scope from merely noting that no corrections are necessary to making as many as 50 corrections (e.g., New York harbor area), will have to be performed every day just for this one class of charts. Coastal charts have been chosen as an example and by no means represent the bulk of NAVOCEANO chart holdings (some 6,000 U.S. and 23,000 total charts in NAVOCEANO's automated chart library).

SHORE-BASED SYSTEM PROPOSED FOR NAVOCEANO

Flexibility and Fail-Safe Characteristics

The maximum-configuration system charted in Figure V-1 is fully duplexed; that is both processors have access to all auxiliary memory and peripheral units. This increases system flexibility and permits continuous system operation simultaneously with maintenance or repair activities.

[1]Based on estimates for the world's coastlines given in Marine Science Affairs. (At least 146,000 miles excluding Polynesia.)

[2]See nautical chart discussion under ESSA-Coast & Geodetic Survey.

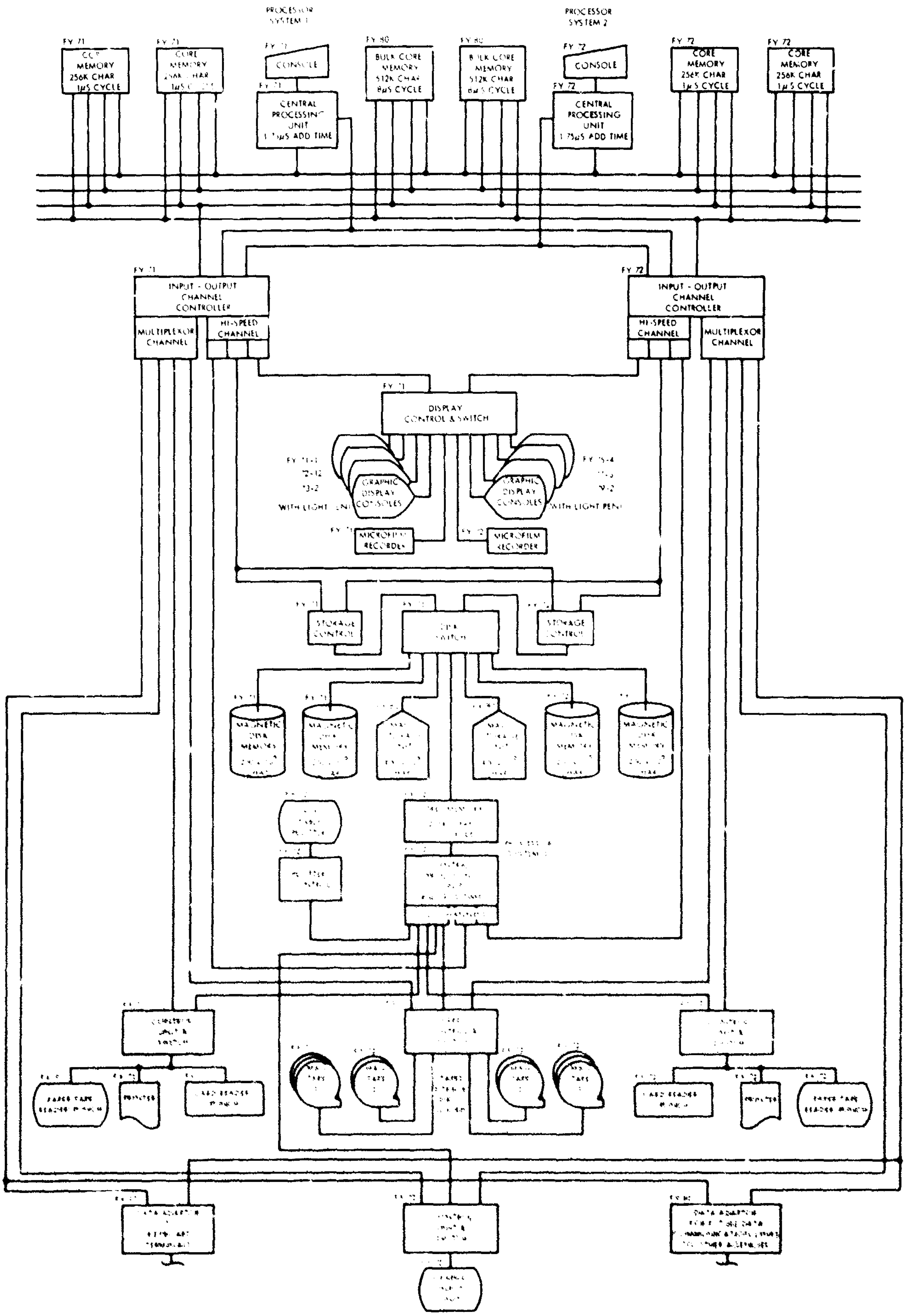

FIGURE V-1. NAVOCEANO SYSTEM

Use of Graphic Display Units

The major use of the 24 graphic light pen CRTs will be in chart updating and quality control--that is, editing of data. (The first of these units will be in operation in 1971.) For example, current information from an automated aids-to-navigation file could be displayed on an optically-ported CRT[1] simultaneously with a projection of a microfilmed chart of the appropriate area. For the present, however, the projection of anything other than digital (computer-readable) information on the CRT remains an experimental technique. Thus, within the off-the-shelf technology for perhaps the next five years, the microfilmed image of the chart would be presented on the screen of a curve-follower and digitized as necessary to outline the coastline, wharves, breakwaters, etc., on the CRT. Software would be necessary for performing coordinate transformations for matching the aids-to-navigation and coastline information (using known fixed aids common to both the chart and the aids file), but such software consists only of a small FORTRAN program and is negligible compared to the large software requirements imposed by basic CRT operation. Assuming that the area in question is part of one mapped on a harbor chart, the effect of newly-reported aids to navigation, shoals, and wrecks, can be estimated by examining their relationship to harbor entrance channels. To give a specific example, it might be found that the position reported for newly established range markers is inconsistent with harbor approach information shown on the microfilmed chart. If a check revealed that the position information for a range marker was mispunched, it could be deleted from the display (and from the data base) with the light pen and corrected information entered via the program function or alphanumeric keyboard. In some cases, where exact position is neither critical nor available (such as areas of kelp, bottom characteristics in anchorages, etc.), symbols or notations may be entered into the display using the light pen.

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[1] Available on special order at present.

The updated display could then be photographed using the microfilm recorder unit and filed in the unit's film storage bank (75,000 photographs amenable to automatic retrieval through coded indices) until it is needed again. The aids-to-navigation and other information on the screen which is in memory could be channeled to the table plotter or scriber for the production of an overlay or overlays to be used in updating the affected charts.

Another use for the graphic display-light pen units will be found in final editing of digital soundings information. Using software, the final soundings tape could be generated by the editor's elimination via the light pen of deep scattering layers, side echoes, and noise pulses. The display could be made to rapidly recapitulate the ship's track, stopping automatically wherever the depth as a function of ship's position is multiple-valued.

Direct Access Storage

Four disk units with removable disk packs to allow on-line storage of up to 920,000 characters is recommended. This capacity will allow a CRT user to expect that, on the average, some 38,000 characters (equivalent to about 480 punched cards) of direct access storage will be available to his display unit at any time, which is consistent with the number of aids-to-navigation and other cultural features which might be expected in populous areas, and should also be sufficient for the bathymetric editing function outlined in the last paragraph.

ESSA-COAST AND GEODETIC SURVEY (C&GS)

The task of providing complete 1:250,000 scale coverage of all U.S. continental shelves (plus continental slopes to the 2,000-meter 150 isobath) will require about 70 more ship-years of effort. There will be about 1.3 X 10^7 recorded soundings involved, with somewhat fewer recorded magnetic and gravity values. This bathymetric data density is about the minimum necessary to accurately map the bottom at 1:250,000 scale. Data density for the geophysical parameters can be less without affecting the integrity of the finished maps. The U.S. shelf slope is slightly over 10^6 square nautical miles and is broken down into 165 separate map areas at the above-mentioned scale. Three to five different maps will be required for each of these areas in order to depict all parameters.

About one ship-year per year is now available for this mapping, so that at the present rate of progress, only about one-seventh of the planned coverage would be accomplished in the next decade. Because of the increased interest in, and importance of, the resources of the continental shelf, it would be desirable to increase the present rate of survey. One alternative would be to fund the acquisition of additional ships for survey work; other alternatives (not necessarily excluding new ship acquisition) could be increased use of high-speed survey vessels and survey launches from "mother ships" and conversion of existing chart survey vessels to mapping use.

The Technical Development Plan recommends the acquisition of 6 additional survey ships during the next decade and the utilization of 6 existing ships in order to provide bathymetric mapping of 70 percent of the Continental Shelf and increased small craft chart geographic coverage.

SHIPBOARD PROCESSING

An automatic data processing facility on board each survey ship would result in faster processing and improved quality of each ship's output (preliminary smooth sheet). Recognizing that platform operation costs far outweigh the cost

of a shipboard computer, we recommend that a computer processing system be acquired for each C&GS survey ship, since even a small increase in efficiency of ship use will amortize the computer cost over the life of the ship. The use of shipboard computer processing equipment has been proven feasible in the NAVOCEANO HYSURCH development program.

NAUTICAL CHARTS

Figure V-2 outlines the shore-based system according to the Technical Development Plan. The large interactive capability recommended will allow semi-annual updating of all nautical charts by FY 80, which is a reasonable upper limit on frequency of updating in that it resolves seasonal effects, e.g., storm damage to aids-to-navigation and shoaling of harbor entrances. At the present time, charts are updated when a specified number of changes to the chart have appeared in the Notice to Mariners. Thus, although an average frequency of updating at present may be quoted (once every three years, based on the accumulation of 30 changes), the time interval between the updating of a specific chart varies widely.

The user, then, has the choice of obtaining his charts from a retail outlet, with all Notices to Mariners issued since the date on the chart, or ordering up-to-date charts from the appropriate agency, which may mean a wait of from two to three weeks for delivery. Semi-annual updating would greatly decrease the trouble to the user of updating his "new" charts, in that at the worst only two dozen issues of the Weekly Notices would have to be examined for corrections instead of (potentially) hundreds of issues.

The system of distribution through retail outlets for semi-annually updated charts would function best if handled in the same manner as the distribution of popular magazines; that is, outdated charts would be returned by the retailer to C&GS (or NAVOCEANO, Lake Survey). Since the updating process, as noted below, would be a continuous process at the chartmaking agency, charts

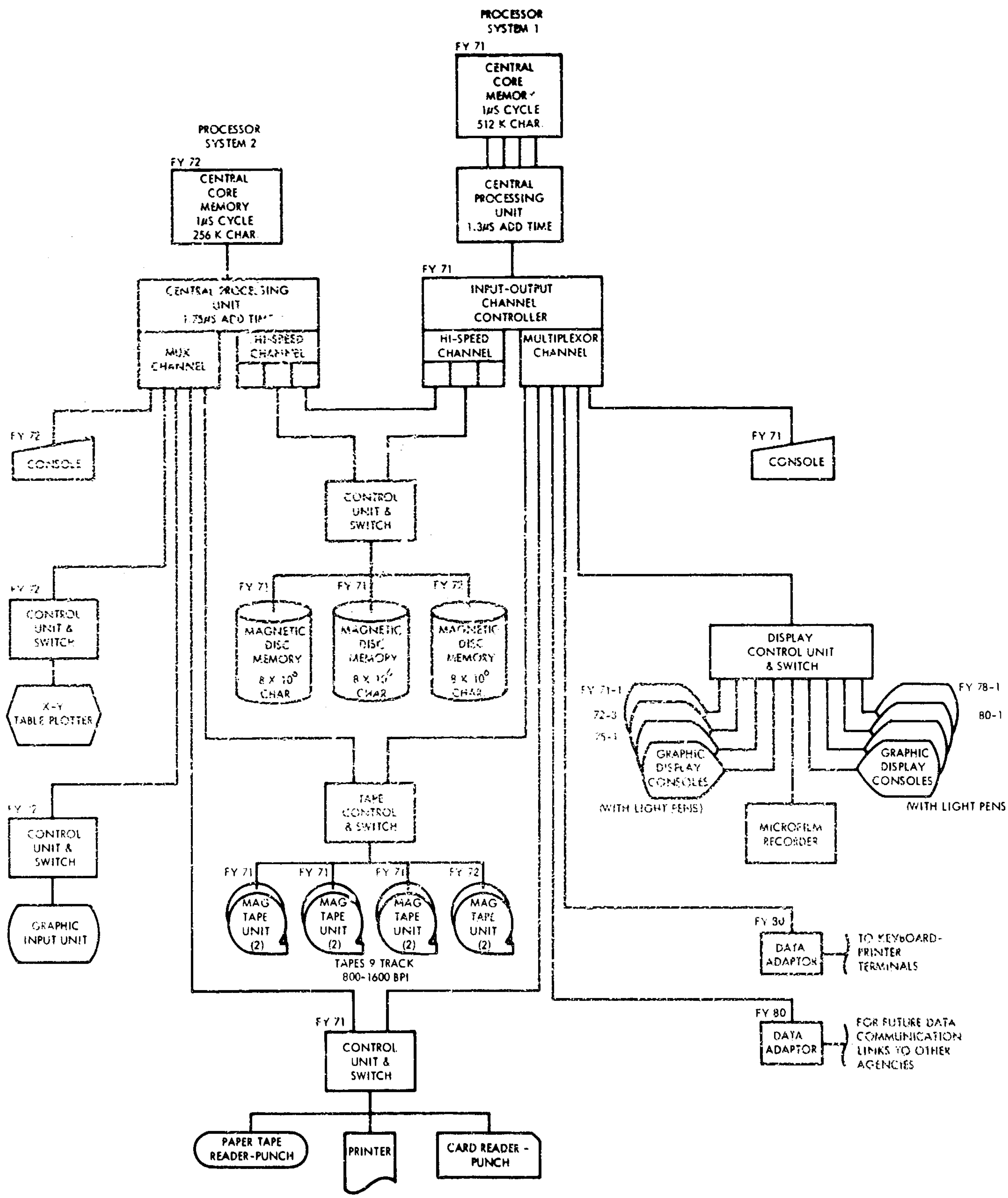

FIGURE V-2. COAST AND GEODETIC SURVEY SYSTEM

could be mailed to dealers more frequently than semi-annually (e.g., quarterly or monthly) if this were found desirable. The return by the dealer of outdated charts would not have to be on the same frequency basis; and in fact it might remain the most economical practice to return only the chart label, as at present.

NOTICE TO MARINERS PRODUCTION

For both C&GS and NAVOCEANO, the data base used in the production of Notices to Mariners should be automated. There are about 50,000 official aids to navigation in the U.S., and another 200,000 cultural features, unmarked obstructions and restricted areas. The necessary information for each of these 250,000 objects (latitude, longitude, elevation, and descriptors) should be put in computer-readable form. The amount of storage needed could be as little as the equivalent of one full 800 bytes-per-inch magnetic tape; but in actuality, several tapes should be used, perhaps one for each of the ten ocean areas, for convenience in access.

Such an automated file would lend itself to the semi-automated, on-line production and correction of nautical charts using CRT displays and light pen techniques. A system with such capability is recommended for C&GS as well as NAVOCEANO chart corrections and entries for the Weekly Notice to Mariners will be much easier to generate because of the ability to check for redundancy of information, inconsistencies in observations, etc.

SURVEY CONTROL INFORMATION SYSTEM

For survey work, an automated file of benchmark positions would be of great utility for checking and processing survey results. For studies of important geological events such as the 1964 Alaskan ("Good Friday") earthquake, such a file would greatly facilitate the evaluation of re-surveys of the affected area.

U.S. ARMY CORPS OF ENGINEERS - LAKE SURVEY DISTRICT AND GREAT LAKES REGIONAL DATA CENTER

The U.S. Lake Survey has responsibility for navigational charts of the Great Lakes and other waterways of the region. The agency also performs studies related to the physical limnology, hydraulics and hydrology of the Great Lakes in cooperation with other Federal agencies, local universities, and Canadian agencies.

Limnology studies include lake water characteristics, water motion, ice and snow studies, water quantity and shore processes investigation.

Geological investigations involve detailed bathymetry of specific areas, such as the present three-year project to study reef areas of western Lake Erie. The Lake Survey has not been previously required to perform detailed bathymetry of the entire Great Lakes system. To do so will require the acquisition of additional ships, since the agency has only two vessels well suited to offshore survey work and these are constantly employed on other projects. There has not been great demand for detailed bathymetric maps in the past, most of the interest in lake bathymetry having been concentrated in specific areas of geological interest. Recent interest in underwater oil production, however, has created a general demand on the part of the oil industry for detailed bathymetry of all the Lakes.

Satisfaction of this demand will require the production of ten bathymetric maps (2,000,000 soundings) at a scale of 1:250,000. The requirements, other than platform acquisition costs, for performing this task are included in the Technical Development Plan (TDP), with the concomitant expansion in Lake Survey personnel, activities, and funding. (If eight small survey

ships were equipped with analog to digital conversion equipment for converting sounding data, as proposed in the TDP, they would begin production of maps in FY 1975 and finish by FY 1978.) Implicit in this plan are two assumptions: first, the cooperation of Canadian surveyors in surveying Canadian waters, and, counterbalancing this help to an extent, the hindering effects of the ice season. The installation of shipboard computers on these new vessels would give the Lake Survey the mobile computing facility which has been specified as desirable in agency plans, as well as facilitate the survey work in the manner described for other surveying agencies.

A total of about 3.5 million observations will have been collected by the Lake Survey by FY 1970, consisting of coastal engineering and water resources data and various fishery, hydrology, and geology studies. The rate of collection of information is estimated to be a half-million observations annually by the Lake Survey District alone. Applying the rule of thumb that, on the average, the information from an "observation" of whatever nature can be contained on one 80-column punched card, the data base size may presently be estimated at 3×10^8 characters when put in computer-readable form. It is growing at the rate of ten percent per year.

An automated aids to navigation file is recommended for the chart maintenance function of Lake Survey. As for NAVOCEANO and C&GS, the term as used here is intended to include cultural features such as piers, bridges, towers and stakes, as well as obstructions, wrecks and buoys. The volume of this file (including Canadian waters) will be comparable with that for the maritime coasts of the U.S.--some 30 to 40 thousand entries. The use of this file, in conjunction with microfilmed information when the graphic display is available, or simply by printout and manual plotting, would be similar to its use by NAVOCEANO, previously described.

Briefly put, it is proposed that recreation chart coverage of the Great Lakes should be completed by FY 1980; presently, the overall coverage is about ten percent.[1] Development and production of climatological atlases for the Great Lakes should begin by FY 1979 and be complete at the end of FY 1980. Other priority products' upgrading schedules are presented in the TDP (Volume Two). A flow chart for the system and its hardware characteristics is given in Figure V-3.

COASTAL ENGINEERING RESEARCH CENTER (CERC)

Activities of CERC include studies of shore processes, such as beach erosion and buildup and the associated sediment (sand) transport; studies of ocean waves and surf and the effect of nearshore waves and surf upon coastal structures; and studies of runup of breakers, tsunamis, and storm surges. These studies range in nature from the gathering of empirical information through observation to basic theoretical research.

Data bases presently maintained at CERC are surf observations (visual), coastal wave gauge records, beach profiles, sand grain size distributions from beaches and from some offshore areas (Atlantic seaboard) to a depth of 50 feet, and littoral environment observations from California, including surf, wind, water temperature and littoral current information plus beach profiles. Information derived from these data is disseminated to Corps of Engineers District Offices, and wave analyses (significant wave parameters, sometimes with spectral analyses) are disseminated to over 1,200 customers who have requested them.

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[1] Present coverage is nil for Lake Superior, ten percent for Lake Michigan, five percent for Lake Huron, 15 percent for Lake Erie, nil for Lake Ontario.

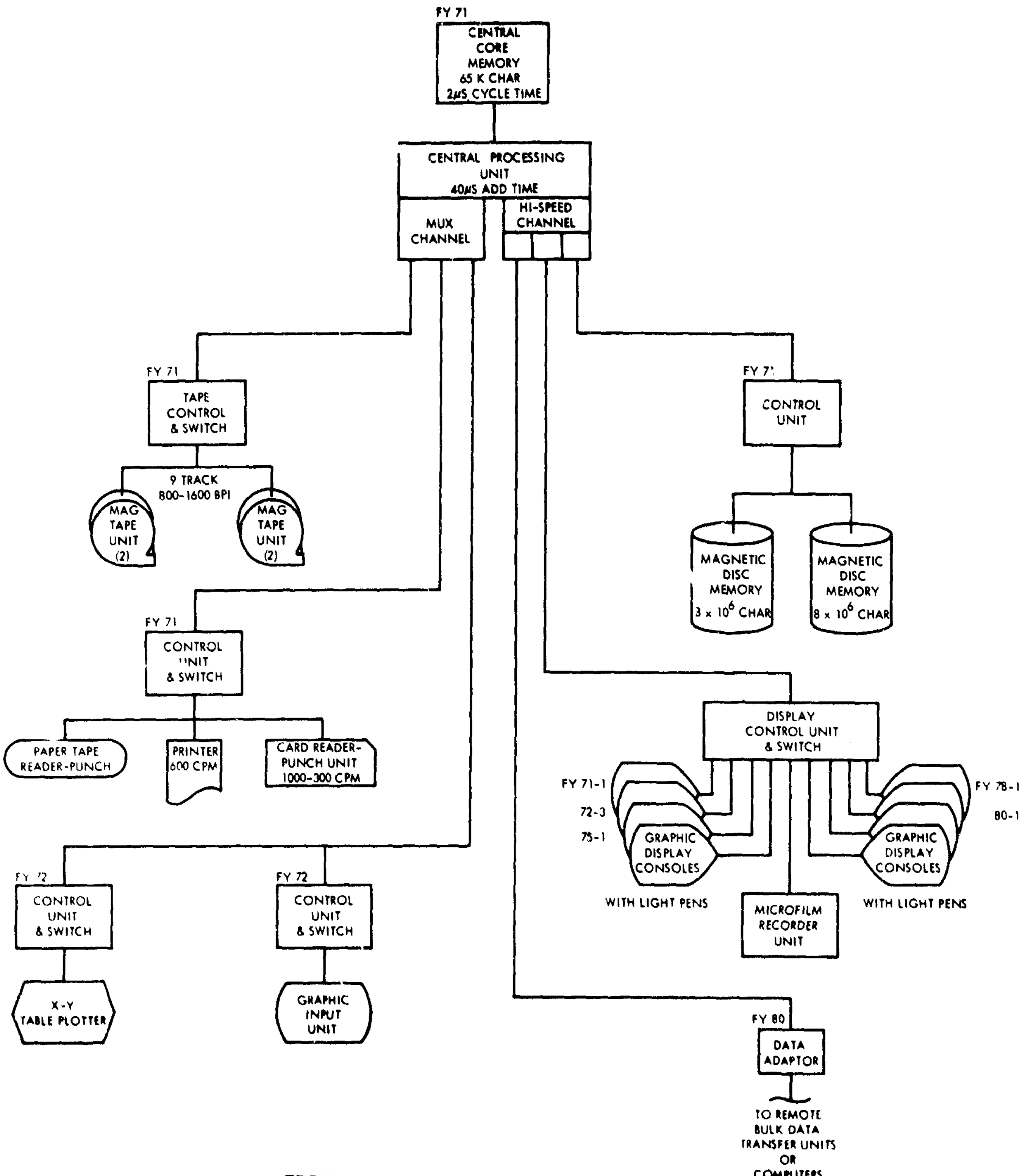

FIGURE V-3 LAKE SURVEY SYSTEM

WAVE GAUGE DATA BACKLOG

CERC has approximately 150 gauge-years of wave gauge data on analog paper tape from previous collections beginning in 1948. A few data are available from earlier years. Approximately 80 gauge-years of data are available on analog magnetic tape. As of January 1969, approximately two years of data were available on computer compatible magnetic tape. The paper tape records consist of seven-minute records, six records per day. The analog magnetic tape records consist of twenty-minute records, six times per day at a rate of .5 inch per minute (.00833 IPS). As of April 1969, 978 standard 1/4-inch analog magnetic tapes were available. The digital tape records, which have been experimental, consist of more or less continuous recordings from Atlantic City at eight samples per second. The continuous recordings from Atlantic City have been discontinued in favor of sequential recording at several stations. Simultaneous recordings from as many as four gauges on the Steel Pier have been obtained for selected periods.

In several cases, two or more types of gauges have been installed on the same pier to compare gauge response. Most of the paper tape records have been analyzed visually by a semiobjective system to determine significant height and period. Selected portions of the magnetic tape records have been subjected to spectrum analysis. There is no plan for performing spectrum analyses on all of the available records.

Comparisons of the records from two different types of gauges on the same pier show statistically significant differences, even when averaged over periods as long as a year. These differences appear to be caused partly by differences in the response of the sensors to identical waves, and partly to the disturbance of the wave field caused by the gauge support.

FIELD WAVE GAUGING DATA ACQUISITION AND PRELIMINARY ANALYSIS SYSTEM

Field Wave Gauging

Four gauges are being operated at Atlantic City as a part of the comparative gauge study. A single gauge is operated at six sites on the East Coast other than Atlantic City, two in the Gulf of Mexico, three on the West Coast and five in the Great Lakes. The practicality of multi-gauge arrays for wave direction detection is being investigated. The ideal number of such gauges and the optimum analysis procedure have not been determined.

It is suspected that about 100 well-selected sites will be needed to establish an adequate data base for a wave climatology for the U.S. coastline. It has not been determined that all of these sites should be occupied at the same time or that 100 is the optimum number.

Data Flow for the Fully Developed System

While CERC does not necessarily intend to operate all 100 stations simultaneously, it is proposed here that U.S. Weather Bureau marine forecasting centers and certain coastal offices tap the gauges appropriate to their areas for coastal wave and surf monitoring and forecasts. For this reason, we suggest that all CERC stations be in fact permanent stations, and not merely operational during the five to ten years' duration of the CERC study project. The use of data from this system by the marine forecast centers will be discussed in the section on ESSA-Weather Bureau.

The Atlantic Coast arrays are to be operational by FY 1971. These ten stations will transmit analog data to CERC via telephone lines; the signals from the three channels will be fed through subcarrier oscillators,[1] multiplexed, modulated for FM/FM transmission and sent by common carrier to a demodulator-discriminator system (already installed) at CERC. The ten

[1] If the sensor's direct output is a frequency rather than a voltage, it may be possible for this step to be bypassed; on the other hand, it may be necessary to add a detector to the front end of the subcarrier oscillator.

stations are to be interrogated one at a time under the control of an A/D converter and control unit, which may be used to select the sample rate. At the same time, a seven-channel FM analog tape recorder records the output of the demodulator and the discriminator for eventual archival, and in case of failure in the downstream system, the analog signals are also displayed on a multichannel strip chart recorder.

Sampling Rates

The forms of the typical ocean wave spectra from coasts bordering the Atlantic and Pacific Oceans and the Gulf of Mexico vary. On the Pacific coast, weather conditions within a few hundred miles of the coast typically produce 7- to 10-second-period waves, and large Pacific storms commonly produce swells of 16-second period (i.e., the maximum energy of storm-produced wave spectrum at the source is commonly at a frequency of 1/16 sec^{-1}). Swell from southern ocean and Indian Ocean storms has been observed with greater than 20-second period when first detected. The wave climate of the East and Gulf Coasts, on the other hand, is characterized by "fair weather" waves of shorter period, typically four to seven seconds, with hurricane-produced swell on the order of 12 to 14 seconds appearing in the fall and North Atlantic storm waves of 8 to 12 second period in winter observed along the Eastern Seaboard. Since the longer-period waves, for the same height, carry greater energy, it is these waves which are responsible for most shore processes involving sediment transport.

The general form of wave spectra is well known, and in the oceans very little power is found in any wave spectrum beyond 1/2 cycle per second, so that a sample rate of 1 sec^{-1} would be sufficient. In cases where ripples are to be

examined, wave lengths as low as 1/2 ı ot (period of the order of 0.3 sec) might be examined, in which cases periods of up to eight samples a second might be used. Such experiments might be better carried out in a wave tank than at a site, however, since neither ordinary wave staffs nor pressure sensors can be expected to show good response at such frequencies. The attenuation length $\lambda/_{2\pi}$ for 1/2 foot-wave length ripples is less than an :h, so that pressure sensors cannot be used to measure these wavelets, and wa staffs suitable for measuring large waves cannot respond to wavelets, because their resolution is insufficient and because of wetting of the staff and resistance wire. Furthermore, the directional resolution for these very short waves would be nil for an array with good resolution at, say, four-second period.

Because of the attenuation of pressure fluctuation due to gravity waves with depth, where pressure sensors are installed in a depth d, a good rule of thumb is to sample at a rate not much greater than

$$\frac{1}{\pi}\sqrt{\frac{2g}{d}} \quad \sec^{-1}$$

If this rate is chosen, then aliased power from just beyond the Nyquist frequency will be attenuated by e^{-4} = -17 dB.[1] Results of applying this rule are given in Table V-1.

[1] The attentuation of pressure with depth d is given by exp $\{-d/x\}$ = exp $\{-dw^2/g\}$. Thus, at an angular frequency $w = 2\pi f$, the number of attenuation lengths n is $\frac{dw^2}{g}$; if f is to be the Nyquist (folding) frequency when the sampling rate is 2f. The choice of n here is n = 2.

Table V-1

SAMPLE RATES AS A FUNCTION OF PRESSURE
SENSOR DEPTH

Pressure, Sensor Depth (feet)	Sample Rate (sec^{-1}) (according to rule)	Reasonable Choice (integral sample interval)
20	.57	1 sec^{-1}
40	.40	0.5 sec^{-1}
200	.18	0.25 sec^{-1}

The main point of judicious limitation of the sampling rate is to avoid unnecessarily long time series. To perform cross-correlation analysis on three time series, each of which contains (say) eight times as many points as are necessary to represent the function, is quite wasteful of computer time. Depending on the algorithm used, as much as a factor of 64 increase in the number of multiplications necessary to compute the spectrum could be made necessary by a sampling rate eight times too high. In practice, numerical filtering of the series would be performed instead; but this, too, is time consuming.

APPLICATIONS OF COMPUTER-AIDED GRAPHICS

One application of graphic display units allowing display control via light pens or alphanumeric keyboard is for mathematical modeling by scientists. These devices should find widespread application at CERC, since the agency deals principally with dynamic processes, the exact analyses of which can be extremely tedious even with the aid of a computer. The essence of the application of graphic displays with interactive capability (hereinafter

referred to simply as "CRT's") is the ability of the user of such a device to "build" and display a mathematical model of the process in which he is interested. The model, in fact, is a working one; it can be turned on and off, and it can be modified.

An example of the use by CERC of CRT's might be in studying waves incident on a beach of uniform slope, choosing various frictional effects at the bottom-water interface to investigate sediment transport. Wave propagation into harbor entrance channels and effects of reflections from structures within the harbor, given various swell directions, could also be mathematically modeled, avoiding the necessity of constructing actual physical models of the harbor and allowing the refractive effects of offshore topography to be automatically taken into account.

THE NATIONAL WEATHER RECORDS CENTER (NWRC)

NWRC, an arm of ESSA's Environmental Data Service, is the archival center for all climatological data gathered by civilian and military agencies. Of the over 3,000 magnetic tapes in NWRC's tape library (the collocated Data Processing Division of Air Weather Service has about 24,000 tapes in its library), 450 tapes contain marine surface observations. This subset of the NWRC data base, called the Marine Surface Observation File, is in itself almost unmanageable on magnetic tape. For example, some 60 hours would be required to search through the entire file, so that requests must be carefully tailored lest their satisfaction be prohibitively expensive.

The weekly, monthly, and annual NWRC climatological publications, as well as unscheduled but planned-for NWRC publications, offer no particular difficulty at present since the data base is managed in accordance with requirements for these publications. The cost of answering requests, however, would be greatly lessened by improving the accessibility of the data base. In addition, a new product such as a set of coastal climatological atlases, for the production of which new sources of data must be developed as well as correlating data already in the data base, would be much easier to produce given a generalized data management capability.

Proposals are advanced here for upgrading the marine data service functions of the National Weather Records Center on the treatment of the marine surface observation file, which now (1969) consists of some 3.4×10^7 observations or about 5×10^9 characters. The two most pressing needs which should be satisfied concurrently with upgrading are the production of coastal climatological atlases and an improvement in the quality of high seas wave and swell atlases.

Marine Surface Observation File Management

As a first step, consideration should be given to the inclusion of additional pertinent land station data in the marine file. If there is an extensive coastal plain, stations far inland might be of interest. In addition, many stations along the coast provide abbreviated, often asynoptic, weather reports to local coast guard stations for broadcast to small craft operators which should be made part of the file. Efforts should also be made to encourage consistency in the taking of observations by coastal shipping and other ships in the coastal zone (say, within 50 miles of land). Purchase of observations from selected fishing vessels should be considered. These measures could provide valuable additional observation density for the production of coastal atlases.

Direct access capability should be acquired for the storage of indicial information, since even an index to the marine surface observation file would occupy several tape reels. Depending on the number of meteorological parameters to be indexed (of a possible 40) in each observation, the index will contain from 10 million to 50 million characters. The index should in its operation generate use and updating (acquisition) statistics to aid in later compaction and reorganization of the data base.

Gathering of data for coastal atlases can begin as soon as the index file is in operation, and will proceed until sufficient data of the appropriate density is on hand. In order to most efficiently produce the atlases, a table x-y plotter should be utilized by NWRC. Computer time should be allocated yearly specifically for program development, not only to implement plotter and index software but also for debugging and miscellaneous improvements to all NWRC data processing routines.

It is considered that coastal and high seas climatological atlases should be updated at ten-year intervals and should contain some charts showing climatological trends, that is, a series of four-year or five-year averages. In view of the apparent long term fluctuations in the earth's climate, it may not be worth the effort to keep all weather data in the active file. The oldest data could be relegated to card or microfilm storage.

The improved wave and swell data referred to above as desiderata must be obtained in the field by agencies other than NWRC and will require instrumentation aboard ships and buoys. Although wave and swell period and height data obtained by visual observation are fairly reliable if taken by experienced observers, instrumented wave and swell data from buoys and ships, with sea state observations from satellites and aircraft when available, should contribute greatly to the overall reliability of sea and swell data.

The compaction and reorganization of the marine surface observation file should begin as soon as use statistics from two or three years are available from the Master Index File. Large capacity disk storage units or data cells could be utilized to store the most frequently accessed data. These units offer the capability of semi-random access (by blocks of data). When the most recent data have been put into this medium, the marine surface observation file will be accessible by any of the meteorological parameters it contains through a revised index file, and most responsive to the most common requests. It should be noted that the restructuring of the data base on a frequency-of-request basis is recommended only after access to the data base is improved, since the nature and number of requests are heavily influenced by the users' knowledge of what is available.

The major justification for interactive access would ultimately be its research application, but it would also serve as an aid in accessing the data base for operational use at Weather Bureau Offices. Initially, only alphanumeric terminals would be made available; teletype terminals could be added at moderate cost in each of 14 Weather Bureau offices with marine responsibilities. Only summaries of the data base for various geographic areas could be put on on-line disc storage. These could be "browsed" using teletypes and CRT's. Software for generalized data management (TS/DMS, GIS, or Auerbach DM-1) would be required for the interactive system.

NATIONAL OCEANOGRAPHIC DATA CENTER (NODC)

DESCRIPTION OF CURRENT AND PLANNED NODC DATA BASES

Physical (Oceanographic) Data

Although surface current atlases presently exist for various regions of the oceans (i.e., H.O. Publication No. 570, Atlas of Surface Currents, Northeastern Pacific), these presentations are not generally suitable for circulation studies.

NODC could contribute materially to the provision of complete descriptions of world-ocean currents if efforts were undertaken to produce new atlases of both dynamic topography and surface drift currents from their existing ocean station and surface current data bases. The latter data base would require the most effort, since it is not as well organized as the station data base. At the present time it consists of some 2.25 million observations of surface drift currents on magnetic tape. Additional surface current data are available on the summary decks of surface data from NWRC. The surface current file contains data obtained from NAVOCEANO and NWRC. The date of the most recent observations for each are: H1-9, 1945; N193, 1930; and J118, 1957. These data are not recent and the value of the observations is questionable. The use of these files with the station data file may not be advisable because of the difference in the quality of data.

NODC could provide some statistical analyses of historical data, from its existing station and BT data bases, which would be of interest to some individuals presently using these data for analyses and for those contemplating new time-series data collection programs. Computer programs already exist at NODC that allow the computation of monthly average, maximum, minimum, standard deviation, etc., of temperature, salinity, and oxygen and sigma-t at standard depths by areas of one or five degrees square.

Chemical Data

No chemical data base exists at NODC; however, plans were laid for its establishment in FY 1965. The ocean station data file does contain nutrient chemistry values with volumes as follows: oxygen--probably more than 100,000 stations; phosphate--more than 40,000 stations; total phosphorus--about 2,000 stations; nitrite--about 7,000 stations; nitrate--about 6,500 stations; silicate--about 16,000 stations; pH--about 17,000 stations. Efforts to satisfy the unfulfilled need for a central chemical data base should be expanded by NODC in the future, as the present volume of chemical data collection can be expected to increase because of the widespread acceptance and use of the Chemical Autonanalyzer by the oceanographic community.

Geological and Geophysical Data

The basic need in this data category, which was for indexes and catalogs containing information on the data and samples themselves, as well as for information on the status of current sampling programs producing geological and geophysical data, has been recently met. NODC is best serving its users by concentrating its efforts in the compilation and production of geological and geophysical data indexes and catalogs, locating and identifying geological and geophysical data bases that are known to be of interest to users and advertising their existence through its newsletter and through oceanographic and trade magazines.

Biological Data

At the present time the development of NODC's biological data base is at a virtual standstill. This is due primarily to the fact that methods of collection vary widely, and collectors are reluctant to invest the time required to format the data properly for inclusion in the data base. NODC personnel are already acquainted with the data collection operations of

most of the major potential biological contributors and could easily incorporate this information into convenient directories and catalogs for use by the general marine community.

Pollution Data

Although a major responsibility for the collection and dissemination of pollution data resides with FWPCA, NODC could contribute to the satisfaction of the need for: (1) nearshore physical and biological data bases for use in pollution studies; and (2) the need for inventories and catalogs of past, current and proposed studies of nearshore pollution problems. NODC has directed some effort towards this goal through participation in the Gulf Marine and Estuarine Inventory (GMEI), through the provision of oceanographic station data for U.S. coastal waters to FWPCA, and through working with the HEW Bureau of Solid Waste Management on the problem of marine data requirements.

Engineering Data

A major unfulfilled need for ocean engineering data are statistical summaries which can be derived from other data categories. For example, statistical wave and current summaries are derived from physical and meteorological data. For the purpose of satisfying ocean engineering users, NODC should develop, for example, statistical summary data bases of surface and subsurface (when data base available) current data.

EXISTING NODC DATA PROGRAMS

In the previous discussion, mention has been made of specific facets of NODC data service operations which, if upgraded, would fulfill important needs in each data category. In the following discussion, several current and planned broadscale NODC programs, products and services are discussed.

National Marine Data Inventory (NAMDI)

NODC has designed a NAMDI questionnaire based on DNP requirements for documenting cruise information. The NAMDI questionnaire includes information on volumes, areas of operation and personnel, and sampling and analytical techniques for 68 data types. The results of 608 cruises from 23 respondents were submitted in 1967, of which 366 cruises were identified as part of the DNP. The 1967 DNP was prepared manually from the NAMDI forms. Presently, NAMDI is operated using the SDC time-shared LUCID data base system on the Q-32 but will be transferred to the SDC time-shared data management system on the IBM 360/67 in the near future.

Plans now call for the compilation of the NAMDI for previous years, back to 1960. This is currently underway at Woods Hole Oceanographic Institution. Other developmental plans regarding NAMDI include a cross-checking with published cruise schedules to provide an estimate of the completeness of the annual NAMDI survey. NODC is currently broadening the coverage of NAMDI to include data collected via other platforms such as buoys, satellites, and aircraft, and from other sources such as States and industry.

Atlases

The production of atlases showing the annual, seasonal, and monthly distributions and variations of oceanographic parameters is a service

already being performed on a limited basis. During the past eight years, NODC has produced and published four atlases (covering the Atlantic and Indian Oceans, and the Persian Gulf) and is currently assisting in the preparation of an atlas describing the results of the International Cooperative Investigation of the Tropical Atlantic (ICITA), which consisted of three major surveys conducted during 1963-1964 and involved 20 vessels from 13 nations. NODC has also produced sound velocity atlases.

Indexing and Abstracting

Over a number of years the American Meteorological Society (AMS), under contract to NODC, has been responsible for (1) indexing accessions from NODC and World Data Center A (WCD-A); (2) preparing abstracts; (3) preparing library cards; (4) searching other libraries for additional literature; (5) issuing periodic accession lists; and (6) compiling special bibliographies. The cost to NODC for this service has been about $32,000 per year. AMS bibliographies related to the stated unfulfilled needs in this report have been published for physical oceanography, marine seismic studies, marine corrosion studies, marine atlases, and general oceanography. In addition to the AMS work, NODC supports an in-house indexing service for biological literature. The retrieval of this literature is at present manual; however, recently a small portion of this data base was entered into the System Development Corporation time-sharing system to test the feasibility of storage and retrieval of the bibliography in such a system in the future.

General Data System

The NODC General Data System (GDS) has been designed to receive and disseminate data in a wide variety of recording formats. This system

was designed primarily to eliminate the problems associated with past attempts by NODC to establish standard formats for the acquisition of marine biological, geological and chemical data. The success of the system depends on the precise description of input data formats. If the location of fields, decimal point position, and measurement units are described, NODC will be able to receive and process data recorded in a wide variety of formats when GDS is fully operational.

NODC Accessions Production Inventory System (NAPIS)

NODC has developed and is now operating a flexible and powerful system for inventorying its data and information holdings. The system, known as NAPIS (for accession-processing inventory [control] system), is particularly suited for the control of the greatly increased variety of oceanographic data and reporting media to which NODC is now becoming responsive.

The cardinal features of the system are its ability to:

1. Identify all pertinent data and information collected from specific expeditions, operations, platforms, etc., even when the data are submitted by diverse activities over a period of years.

2. Locate the data within NODC; i.e., identify the archival, disposition, type of processing performed, applicable data base(s), and retrieve accompanying descriptive and explantory material.

3. Identify data sets in terms of reference of the data originator or in terms of reference generally available to requesters of data.

4. Provide a continual inventory of the volume of NODC's holdings of the various oceanographic parameters, data products, and information items.

The system is presently operated semi-manually and will shortly become established in a computer time-sharing mode with instant query and status report capability. It is also a vital first component of NODC's developing General Data System.

Live Atlas

The development of a live atlas is a cooperative effort with NAVOCEANO. The objective of the live atlas is the use of historical data in solving problems in real-time. NODC, through its arrangement with NAVOCEANO, plans to acquire copies of the computed North Atlantic Ocean station data on tape, with the live atlas software, for implementation on the NODC computer system. Through the use of the CRT inquiry/display devices planned for the system, NODC customers will be able to interact with the live atlas data base on an on-line basis.

NEW NODC DATA PROGRAMS

Access to Data Holdings of Other Agencies

NODC could more effectively serve the marine community if it had better access to other marine data bases, such as NWRC's synoptic marine weather observations and FNWC's XBT data. The Technical Development Plan contains recommendations for magnetic tape to magnetic tape transfer of data between NODC and NWRC and between NODC and FNWC. It also contains provisions for establishing on-line inquiry of NWRC data bases by NODC.

Oceanographic Computer Programs

NODC could assist the marine community by taking the lead in establishing arrangements for sharing marine computer programs, developing an inventory of programs and forming a marine computer user organization, similar to computer

user groups in other fields. NODC, as the coordinating body, could direct its efforts toward the establishment of standard data processing programs, compatible for input into its data bases. In this manner the flow of certain classes of oceanographic data could be streamlined for the ultimate benefit of the total marine user community. NODC could serve as a referral center for user requests for information regarding the availability of existing software programs, thus saving the user the cost of developing and debugging a program that is already in existence and suitable for the user's needs. Also, the forming of a vocal user group would serve as a stimulus to computer manufacturers to develop software for marine applications.

Liaison Efforts: Regional Offices

There is a need for NODC to broaden its efforts in customer service by establishing regional or branch offices within the user community. Teletype communication, initially, and computer terminal communication, eventually, with NODC from user locations could also be established for the purpose of answering requests for data. Branch operations would allow NODC representatives to work closely with the customer to assist him in defining his request in terms consistent with NODC's capabilities. It would also result in increased rapport with a wider range of users in State, university and industrial organizations.

Personnel

Funds have been allocated to recruit data processing and management personnel to assist in the operation of the new computer system. Many of NODC's future plans for improved services depend on the effective utilization of its new computer system. Therefore, it is recommended that the NODC staff be augmented with senior grade computer specialist with extensive (at least 10 years) computer system experience by FY 71.

SMITHSONIAN OCEANOGRAPHIC SORTING CENTER (SOSC)

The SOSC was established in 1962 for the specific purpose of providing services in systematic marine biology. The functions of SOSC are to collect, preserve, sort, and store biological specimens; to distribute these specimens, with all of the collection and environmental data, to selected marine biologists for analysis; and to permanently record the results of the analyses and related scientific investigations. In addition, SOSC performs similar services for geological specimens such as cores, grab, and dredge samples.

Preserved biological specimens are referred by SOSC to one or several of 250 carefully selected specialists for study, and the results of the study are returned to SOSC by the investigator. The processing, from date of receipt of the specimens at SOSC until completion of a definitive analysis, may occupy a period of several years. One of the objectives of the SOSC is to shorten this period.

SOSC has developed a data system for storing and retrieving taxonomic and descriptive information for each specimen processed. The current objective is to build up the data base and develop a capability for flexible selective retrieval; for example, by expedition, species, location, time, and method of collection. In view of the increasing national interest in marine biological problems, the close interaction of SOSC with other Federal agencies, and the future need to understand and exploit the geological productivity and mineral resources of the seas, a strong need exists for accelerated development of this data system and the associated data base.

SOSC Data Management Functions

It has been aptly stated[1] that specimens are a form of library resource, and that the retrieval of information about specimens and based on specimens is a form of the traditional library function. This library or information

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[1]By Dr. Donald F. Squires, Deputy Director of the Museum of Natural History.

retrieval function is one which is presently undergoing far-reaching technological change based on automated data processing. For SOSC, the full range of difficulty in the library information retrieval process presents itself. Much attention must be given to problems arising from requirements for variable-field format and a much larger character set than that required for scientific computational applications.

ADP Equipment for SOSC

For the fulfillment of its mission over the next decade the SOSC should have access to a non-word-oriented processor. The peripheral equipment should include the most advanced printers, with upper and lower case capability and the full range of EBCDIC (Extended Binary Coded Decimal Interchange Code) characters. Storage capability for SOSC functions will be large. It is estimated that there are 50 million Smithsonian specimens, which would require about 5 billion characters storage if conventional coding is used. A highly compressed numeric coding scheme (possibly binary) would have to be employed to make the complete storage of this data base feasible. The numeric code would be expanded to the full alphanumeric description by programmed instructions prior to outputting the data. On input, the normal length specimen description would be coded and stored in compressed form. One method of accomplishing this is explained in the Technical Development Plan (Volume Two).

U.S. COAST GUARD - OCEANOGRAPHIC UNIT AND INTERNATIONAL ICE PATROL

The U.S. Coast Guard is perhaps unique among the military services of the world in that its basic function is humanitarian and scientific, its military functions representing a secondary activity. The search and rescue operations of the Coast Guard are not dealt with here, insofar as they depend on action and seamanship rather than data processing. The computer capability which the Coast Guard is now acquiring, however, will find application in the maintenance of a file of information on current marine activities, e.g., current ship positions for use in AMVER system operations. Two Coast Guard activities which will benefit from a shipboard computing ability are discussed below.

COAST GUARD OCEANOGRAPHIC UNIT (CGOU)

CGOU conducts such oceanographic research as is deemed to be in the national interest, either in cooperation with other agencies or independently to the limits of available resources. Particular areas of activity include studies of oceanic current systems, radioactivity and other pollution studies, air-sea interaction studies, and collection of data for oceanographic prediction. The last-mentioned activity necessitates the taking of salinity-temperature-depth profiles, development of time series of current system cross sections, and development of information about bottom water masses.

INTERNATIONAL ICE PATROL

The ice patrol was initiated in 1914 and has had a perfect record since its inception. No ship has been lost due to an iceberg encounter in the patrolled

area (Grand Banks and approaches) during the existence of the patrol. With present day communications and radar, it is likely that the probability of ship-iceberg collision is decreasing with time. To further ensure the maintenance of this safety record, the Ice Patrol is developing iceberg drift and melting predictions based on meteorological and oceanographic data.

COAST GUARD SHIPBOARD COMPUTERS

The Coast Guard has already realized the utility of shipboard computers for both the above applications (oceanography in general, and iceberg predictions) and is proceeding to acquire 39 small digital machines.[1] The Coast Guard's choice is an excellent one. In spite of the small cost of the computers, they are capable of time-sharing, can perform floating point arithmetic, and offer parity checks and read-only storage, and a memory which is expandable to 32,768 16-bit words. Twenty-four I/O channels are available, and up to 16 peripheral devices may furnish input to core memory through multiplexing for a real-time monitoring program.

These computers will allow integration of oceanographic data for CGOU programs, and the reduction of raw data from GEK and STD measurements to current profiles and density profiles. For iceberg predictions, measurements or estimates of the amount of ice above water could be combined with water column property (temperature, density, and salinity) profiles taken around the iceberg to derive its melting rate on station.

For the ocean station vessels and other vessels operated by CGOU, the computer will be used for computations of sigma-t (density -1), calibration corrections on thermometers, interpolation of profile information to standard depths,

[1] Honeywell DDP 516.

processing data from radiosonde or rawinsonde observations, and multitudinous special purpose calculations for research projects. The real time capability of the computer will allow reduction of weather balloon data concurrently with the balloon's ascent.

Cruise and data reports from computer-aided operations should be much better organized and more readily publishable than has been the case for cruises undertaken without ADP capability. Much of the shore-based facilities processing will be obviated, since calibrations and reductions to standard depth will be done at sea in near-real time. Quality control, digital plotting, and retransmission of data to NODC and FNWC will be the major functions of the CGOU shore-based computer (a CDC-3300 is scheduled for installation at the CGOU in October, 1969).

U.S. COAST GUARD - NATIONAL DATA BUOY SYSTEMS (NDBS)

The Coast Guard has been given the task of development of the ability to implement National Data Buoy Systems. With the assistance of contractors, the Coast Guard has analyzed the overall requirements for these systems and is now in the early stages of a developmental program that will lead to a prototype (pilot) buoy network by the end of 1975. The project plans also provides for a demonstration in the ocean of a pre-prototype buoys of high and low sensing capability in the 1972-1973 time frame.

While many problems must be solved before data buoy systems are operational, the largest single technical problem in the buoy system development is sensor survivability, reliability and accuracy for periods of a year or more. While sensors exist for measurement of many important variables, there are few if any sensors in existence today that will stand up for long periods in the ocean environment. A major development program is required in this area. Buoy platform and moorings have a major impact on the design of other components and therefore must be analyzed and tested early in the development program.

Finally, the data that is gathered from this system must be processed and in the proper format for use prior to being sent to the users.

FEDERAL WATER POLLUTION CONTROL AGENCY (FWPCA)

At present, standards for marine water quality have been established, but methods for monitoring marine water quality have not. There is need for further development of in situ sensors, but there is also a need for greater knowledge of pollutants and their effects. While estuarine water quality may be monitored by monitoring the freshwater streams entering and estimating the flushing rate, the rate of pollution of coastal and offshore marine water and the effects of various pollutants are largely unknown.

Stations for pollution monitoring should be established in selected estuaries, without awaiting further study of instrumentation or the results of research in specific areas. The instrumentation should be as comprehensive a set of in situ chemical sensors as is available and the stations should be designed to accept additional sensors as they are developed. Dissolved oxygen, CO_2, and pH may be measured in situ today, although some development work would be necessary for the first lot of instruments acquired. Manned stations could report more parameters, such as phosphates, organic nitrogen, etc. Physical parameters--water temperature, salinity, and particulate matter, for example--would be measured as well as chemical. Certain stations might well be equipped with wave sensors and meteorological sensors as well, i.e., shared with other agencies.

The Technical Development Plan recommends the installation at seven selected estuaries or coastal locations, corresponding to the seven regional FWPCA offices of sensors and telemetry equipment for the continuous monitoring and transmission of water quality data to the STORET system in Washington, D.C. This system would serve as a test bed for determining the feasibility of remote operation of continuous pollution monitoring and control.

Summaries and charts or pollution maps, could be prepared from the STORET data base, which is created from the newly acquired data, on a monthly or seasonal basis for each area. The production and dissemination of these products would be geared to the needs (both for the products and for the information) of State and regional planners and water quality control boards, as well as to BCF for its use in studying coastal fisheries.

BUREAU OF COMMERCIAL FISHERIES (BCF)

The Bureau of Commercial Fisheries (BCF), an agency of the Department of the Interior, is responsible for support of the national program in fisheries development and seafood technology. Specifically, its mission is: a) the assessment, development, and management of fisheries resources, and b) technical and economic assistance to the commercial fishing industry. BCF collects and publishes data on physical, biological, chemical, geological, and acoustic oceanography, as well as on commercial fish catches.

Because of the decentralized character of the fishing industry, regular contact between BCF data gathering staff members and industry people is the only feasible way of eliciting catch data from industry. Since the data are, when current, proprietary in nature, complete information can be obtained only on a basis of trust. This implies the necessity for a large BCF data coll   ion staff which exhibits a low personnel turnover, so that the BCF agent will be known by his industrial contacts. BCF long-range plans should include an expansion in the number of BCF field representatives (and, if necessary to maintain a low turnover, an upgrading of salary scales) for the purpose of gathering more complete and timely statistics from the industry.

An increased data collection effort must be accompanied by a more expeditious processing of the data for the production of fishery statistics reports. At present, monthly statistical summaries are published three to four months after the month summarized, and the delay in publication of the annual report

is about two years. These delays do not reflect on the personnel currently responsible for the reports, but only on their number and to some extent the lack of quality and format control on input data. The 1964 annual report, for example, a document of 541 pages, was produced from statistical collections varying widely in format and currency by a staff of seven personnel operating on a budget of less than $100,000, concurrently with the production of monthly reports. Clearly, both an increase in personnel and budget, and the infusion of technology is needed to produce monthly summaries and the annual report on a more timely basis.

This increase in effort need not be centralized; rather, the task of statistical compilation should be broken down by regional areas. In Table V-2 eight regional statistical centers are recommended for consideration. It is contemplated that each of these centers would produce the monthly reports for fisheries in its area (only representative major fisheries are indicated in the table). Other local BCF offices and BSF&W offices would serve as collection points and disseminators of information to the user community; several of these are listed by way of example. All centers in the network, other than the center at Washington, would disseminate abundance forecasts and advisories as these products are developed.

The BCF centers at Honolulu and Auke Bay, Alaska, are not proposed to be linked with BCF, Washington, as are the other six statistical centers. It is suggested instead that data communication between these areas and the Branch of Statistics in Washington, D.C., be accomplished by mailing magnetic tapes. This course is suggested because of the high line charges involved in linking Auke Bay and Honolulu to Washington, D.C. For Alaskan fisheries, the alternative of linking Auke Bay to Seattle should be considered if the overlap in fishing operations between the fleet from Seattle and Alaskan ports proves too extensive to resolve; in this case, Auke Bay need not serve as a statistical center.

TABLE V-2

PROPOSED SCHEDULE OF IMPLEMENTATION OF DATA ACQUISITION, COMMUNICATION, AND PROCESSING FOR IMPROVED FISHERY PRODUCTS - BUREAU OF COMMERCIAL FISHERIES (BCF) AND BUREAU OF SPORT FISHERIES AND WILDLIFE (BSF&W)

BCF PRIORITY PRODUCTS: FISHERY ADVISORY (A), ABUNDANCE FORECAST (F), FISHERY PRODUCT REPORT (P), FISHERY RESOURCE ATLAS (R), FISHERY STATISTICS REPORT (S)

BSF&W PRIORITY PRODUCTS: SPORT FISHING ATLAS (A), FISHERY STATISTICS REPORT (S)

BCF LOCATION	FISHERY	PROPOSED TYPE OF PRIORITY PRODUCT	IMPLEMENTATION DATE FOR AUTOMATIC DATA PROCESSING SYSTEM (FISCAL YEAR)	IMPLEMENTATION DATE FOR REMOTE TERMINAL (FISCAL YEAR)	REMOTE TERMINAL CONNECTED TO
LA JOLLA	WEST COAST TUNA	A F P S	1972	1973	WASHINGTON, D.C.
SEATTLE	NORTHEASTERN PACIFIC SALMON	A F P S R	1973	1974	WASHINGTON, D.C.
GALVESTON	GULF OF MEXICO SHRIMP	A F P S	1972	1973	WASHINGTON, D.C.
BEAUFORT	ATLANTIC AND GULF MENHADEN	A F P S	1973	1974	WASHINGTON, D.C.
WOODS HOLE	NEW ENGLAND GROUNDFISH	A F P S	1973	[illegible]	WASHINGTON, D.C.
ANN ARBOR	GREAT LAKES ALEWIFE	A F P S R	1975	1976	WASHINGTON, D.C.
AUKE BAY	KING CRAB SALMON	A F P S	1973	--	--
HONOLULU	TUNA	A F P S	[illegible]	--	--
TERMINAL ISLAND	--	P S	--	[illegible]	BCF - LA JOLLA
PASCAGOULA	--	P S R	--	[illegible]	BCF - GALVESTON
ST. PETERSBURG	--	P S	--	[illegible]	BCF - GALVESTON
MIAMI	--	P S R	--	[illegible]	BCF - GALVESTON BCF - BEAUFORT
NEW YORK	--	P S	--	[illegible]	BCF - WOODS HOLE
GLOUCESTER	--	P S R	--	[illegible]	BCF - WOODS HOLE
BOOTHBAY HARBOR	--	P S	--	[illegible]	[illegible]
CHICAGO	--	P S	--	[illegible]	BCF - ANN ARBOR
BRANCH OF STATISTICS WASHINGTON, D.C. [illegible]	--	ANNUAL FISHERY STATISTICS REPORT	[illegible][1]	--	
BSF&W LOCATION					
SANDY HOOK	--	A, S		[illegible]	[illegible]
PANAMA CITY	--	A, S		[illegible]	BCF - GALVESTON
TIBURON	--	A, S		[illegible]	BCF - LA JOLLA
WASHINGTON, D.C.	--	ANNUAL FISHERY STATISTICS REPORT	[illegible]	[illegible]	

[1] [illegible]

With sufficient personnel and a decentralized network for the flow of statistical information, it should be possible to produce monthly statistical summaries within the following month and annual summaries within the first quarters of the following year. In addition to the benefits which will accrue to the fishing fleets and shore-based industry from current, accurate statistics, the Federal Government will benefit in its negotiations with foreign governments concerning international fishery regulations.

U.S. GEOLOGICAL SURVEY (USGS)

The USGS manages and shares the use of the Department of the Interior Computer Facility with other Interior agencies. These include BCF and FWPCA, discussed in the preceding sections.

MISSION OF USGS RELATIVE TO THE MARINE ENVIRONMENT

Within the framework of its responsibility for the appraisal of U.S. mineral and water resources, USGS probes the geology of the continental shelf and deep ocean basin in order to assess their resource potential. USGS and ESSA-WB each have responsibilities in the area of hydrology; ESSA-WB for monitoring and predicting water quantity in streams, rivers and lakes, and USGS for water composition and quality (e.g., mineral content) and water table assessment. The interest of USGS in estuarine processes falls directly under the purview of this study.

USGS MARINE DATA FUNCTIONS

Marine data products of USGS, together with the rest of the agencies' products, are scientific and technical, designed for the use of experts rather than for the layman. Papers and reports of USGS meet editorial and technical content standards simi[illegible] to those of the leading geological and geophysical publications. Thus the data management characteristics of USGS are essentially the same as those of any large scientific research institution dedicated to a particular discipline or set of disciplines.

Map and Document Inventory

The complexity of geological boundaries alone renders digitization of the information contained on any but the smallest-scale (e.g., showing at least one entire continent) geological map a hopeless task. Indices of map holding and summary information concerning maps, however, is amenable to digitization. In the same manner, document inventories should be maintained covering books and periodicals held at USGS.

Time-Shared Data Management Applications

Although not entirely within the purview of this report, the interaction between the hydrologic responsibilities of USGS and FWPCA, a sharer of the Interior comput... system, should not be overlooked. The computer center should provide display consoles and time-shared data management softwar so that USGS and FWPCA may share water quality data bases.

Specific recommendations for product and data base development and hardware and software requirements for USGS will be found in the Technical Development Plan (Volume II of this report).

ESSA FUNCTIONS RELATED TO MARINE METEOROLOGY

ESSA's Weather Bureau **Marine Weather Service** Program has been briefly described in Chapter II. In this section, we wish to point out certain functions which will undergo technological change in the near future, or for which change is already underway.

NATIONAL METEOROLOGICAL CENTER (NMC)

NMC processing is, of course, not restricted to marine meteorological data, but includes all data received worldwide for a given synoptic time.[1] Surface observations are processed and include about 50,000 reports daily, of which 1,800 are from island stations, ships, and buoys. By 1972, it is planned that these marine reports will increase to about 10,000. About 1,500 upper air reports are processed daily, 80 coming from ships and island stations. Plans call for an additional 100 ship/island stations upper air reports by 1972.

Description of NMC Current and Planned Computer System

The NMC current computer system consists of two IBM 360/30 computers for receipt and dissemination of data, an IBM 7094 for data processing, analysis and generation of output products, and the use of the ESSA CDC 6600 for the computation of the 6-layer P.E. Model. Immediate plans call for the upgrading of the 360/30 system to 360/40, and decommissioning the 7094 by converting these programs to the more powerful CDC 6600. ESSA expects to be operating two CDC 6600's by mid-FY 1970. In addition to these large-scale systems, NMC operates peripheral electronic data-processing equipment such as curve following devices, CRT displays, and hard-copy printers. Future improvements include very high speed graphic and digital output products in final form from a 6600, which will be ready for direct distribution to users.

[1] Synoptic time for meteorological observation is 0000Z, 0600Z, 1200Z, and 1800Z. Depending on the need, additional and special observations may be taken at three-hour intervals (e.g., USWB, ships in area of cyclogenesis) or even hourly (e.g., for aircraft operations).

WEATHER BUREAU OFFICES HAVING MARINE FORECAST RESPONSIBILITIES

During the decade covered by FY 1971 to 1980, it is planned to establish six Marine Forecast Centers. These will be at San Francisco, Washington, D.C., Anchorage, Honolulu, Chicago, and Miami (listed here roughly in the order of planned establishment). The Marine Forecast Centers will be completely staffed to discharge their responsibilities for preparation and dissemination of marine products. In addition, Weather Bureau offices having marine environmental prediction responsibility will augment their staffs to include at least one marine meteorologist. The Federal Plan for Marine Meteorological Services includes a program for training meteorologists in physical oceanography, utilizing both in-house programs and post-graduate training, so that positions may be filled at the six regional offices and 33 other offices in coastal and Great Lakes states. The implementation of the Federal Plan will require also the assistance in program management and development of a senior marine meteorologist on the Weather Bureau's Washington staff. This aspect of the Federal Plan will help fill the burgeoning needs of diverse marine users for marine environmental products by providing personnel versed in the specialized techniques and skills required for marine environmental prediction products responsive to user needs.

Installation of computers and equipment at the Marine Forecast Centers and Weather Bureau Offices having marine forecast responsibilities would allow manipulation of local observational and other data and generation of new services and products, such as products which include greater detail with respect to small scale phenomena (a possible example would be a local numerical atmospheric model, using hemispheric information from NMC and local topography as boundary conditions). An in-house computer at the MFC's and other WBO's would allow rapid storm-surge computations, anomalous tides due to meteorological conditions coupled with local resonance effects, and expeditious preparation of other products involving elaborate computations, such as surf forecasts.

For the MFC's and other coastal area Weather Bureau Offices, as appropriate, we recommend a tie-in to wave gauges of the CERC wave gauge network, for the purpose of monitoring nearshore wave and surf activity. The computer capability necessary is described in the Technical Development Plan (Volume Two).

NATIONAL ENVIRONMENTAL SATELLITE CENTER (NESC)

The responsibility of NESC in the marine area is to collect and observe various marine data via remote sensing (including both oceanographic and meteorological parameters), and support research and development in the optimum use of satellites for sensing and measuring the ocean environment.

Example of Data Acquisition and Processing: AVCS System

The Advanced Vidicon Camera Subsystem (AVCS) provides global cloud picture coverage of the lighted part of the earth at a two-mile scan line resolution. About 3×10^9 data points per orbit (per device) are expected, with six bits per data point. Total volume per day is 2.29×10^{11} bits. The system has been flown with some of the ESSA and NIMBUS series of satellites (orbital periods range from 107 to 114 minutes). AVCS image data are collected from the satellite at two interrogation stations--Gilmore Creek, Alaska, and Wallops Island, Virginia--as the satellite passes over. These stations transmit the taped video data as an FM signal to NESC, where it is demodulated and digitized over a 16-level range. The data are then put into a CDC-160A, where they are formatted (15 four-bit bytes per 60 bit word) for final processing in the CDC 6600, along with predicted orbital ephemeris data and data representing right ascension and declination of the negative spin axis. The data points are corrected for brightness vignetting (enhancement), and earth-located with corrections for image distortion. The individual brightness samples (in the 16 level scheme) are then replotted from the original perspective into a two-mile square grid mesh placed on a standard mercator map. An image is then produced on an on-line CRT accepting 2048 x 2048 brightness samples, and is photographed. A similar stereo polargraphic projection is made by

aligning the square mesh with, and making a superset of, the conventional numerical weather prediction grid used by NMC and FNWC. A tape is generated for archiving containing ephemeris data and identification information such as pass numbers contained on the tape, spin data, etc. An unenhanced picture (without a superimposed grid) can be produced directly by playing the video tape into a Murihead display device which produces a glossy print.

Derived data products from the existing AVCS sensors include:

1. Cirrus level winds derived from plumes in the subtropics. This has been tested with NASA ATS data.

2. Mean humidity values derived from cloud patterns for numerical weather prediction (NWP) grid points.

Systems under Development

A data processing procedure similar to that outlined above is expected to be followed when additional sensors are gathering data, except that the problem of data selection aboard the satellite will become increasingly important. Sensors and systems under development are exemplified by the latest NIMBUS-B (NIMBUS 3) package of seven experiments. These include radiometers for the observation of the dark side of the earth and for measurement of radiation balance; the SIRS (Satellite Infrared Spectrometer) system for obtaining a vertical temperature profile in the atmosphere beneath the spacecraft, a one-mile resolution camera (image dissector camera), a system designed to locate variously mounted transponders on earth, an IR interferometer to obtain vertical profiles of atmospheric constituents as well as temperature, and an ultraviolet sensor for stratospheric and ionospheric studies.

Present Products and Services of NESC

At present, the NESC produces 75 computer products, 13 manual products and 12 photo products per day. The computer products use basically the same data and produce selected area pictures, average brightness pictures, etc. Photo products are produced from a direct readout of the analog tape on a Murihead recorder. Latitude and longitude grids are manually drawn and the photos are then put on a facsimile net.

Other outputs from NESC are satellite storm advisories and miscellaneous satellite bulletins (521 and 869, respectively, were issued in 1967). These are prepared manually when photos show large-scale pressure systems not covered in normal forecasts.

The total number of products produced by NESC annually is about 40,000.

Focus of the Data Management Problem

Although most of the sensors described above are experimental, it is probable that many of them will become operational. Many other remote sensing systems exist in various stages of development (e.g., the radar scatterometer for sea state determination). Collection of data from space may be expected always to be limited by the ability of ground stations to process data in real time for displays. The demands of satellite data processing may be expected to motivate advances in the state of the art in real time data processing.

Significant data management problems relate to the archival storage of the expected masses of data and their retrieval for future use. If, as has been done above, imagery data is discussed as if it were digitized to the resolution of the sensor (camera) which obtained it, astronomical numbers of bits per sensor per day are obtained; certainly within a ten-year time frame, it is inconceivable that imagery data will actually be stored digitally. Data which

are collected by linear scanning (i.e., not area scanning), will probably be stored on magnetic tape for archival after analysis; but the imagery data will be hard copy, reduced to microfilm to the extent that requirements for resolution allow.

The data management problem, then, is one of indexing and providing physical storage amenable to quick access. Images and other data from operational satellite systems should be accessible by at least position, date and time, and type of measurement, and not only by mission (satellite) and orbit or pass number.

NESC Requirements for Increased ADP Capability

Since the formation of NESC, the agency has shared the use of the CDC 6600 with the National Meteorological Center, with which NESC is co-located. Both agencies will benefit when NESC acquires its own equipment. This acquisition should be expedited, both because NMC activities will require additional computer time and because NESC, in developing archival storage procedures for satellite data in addition to performing its real-time and near-real time analysis functions will require at least full time on a large scientific machine.

NAVAL WEATHER SERVICE COMMAND (NAVWEASERVCOM)

The Naval Weather Service Command has responsibility for providing meteorological services and operational oceanographic forecasts and analyses to DOD elements as required. In addition, NAVWEASERVCOM provides technical guidance and direction in meteorological matters throughout the naval service.

FLEET NUMERICAL WEATHER CENTRAL (FLENUMWEACEN)

FLENUMWEACEN has the responsibility for supporting the Fleet Weather Centrals/Fleet Weather Facilities (FLEWEACEN/FLEWEAFACs) in providing weather and oceanographic analyses and forecasts. As a Naval Weather Service Unit it may make available to any government agency or private enterprise, upon request, unclassified meteorological and operational oceanographic information which is produced routinely and is not readily available elsewhere or in conflict with services from local government agencies or private enterprise. Fishery support services are an example of the last-mentioned services, going to the BCF, then to commercial fishermen.

FLENUMWEACEN has an automated system of handling data in and out, and extensive numerical prediction techniques are employed. FLENUMWEACEN produces both oceanographic and meteorological products and treats the ocean-atmosphere as one system to the extent possible within present-day knowledge. Weather data are analyzed for an estimate of the surface wind field, which is in turn used in sea state and sea air heat exchange analyses. Cloud cover, relative humidity and sea surface temperature are also considered in estimating heat exchange. Sea state is important because wind waves cause forced mixing, which affects the mixed layer depth and temperature and the depth of the thermocline. The location of the thermocline is pertinent to the determination of the subsurface thermal structure, which is necessary for ray tracing and sound velocity computation. Surface weather data are also used in predicting ice formation and melting. An extensive computing facility at Monterey, California, is used exclusively for naval numerical weather and oceanographic analyses, prediction and research.

The grid system used as the basis for the numerical analyses and predictions is essentially the same one used at NMC, although with slightly different boundaries. The Navy, Weather Bureau, and Air Force developed the overall technology as part of the Joint Numerical Weather Prediction effort started

in 1954. Since then, FLENUMWEACEN has expanded its efforts to include oceanographic predictions, to meet the requirements of naval environmental prediction. The present FLENUMWEACEN model uses 9 atmospheric pressure levels and 12 subsurface levels.

Links from FLENUMWEACEN to Other Agencies

At present, a data link exists from FLENUMWEACEN to BCF (La Jolla) for dissemination of various oceanographic parameters. A comparable direct data tie-in between FLENUMWEACEN and NESC will be needed when satellite data on sea state, cirrus wind derivations, atmospheric soundings, and snow cover are available from NESC on a regular and current basis. A magnetic-tape-to-magnetic-tape link with NODC should be established for the transfer of digitized and processed BT data into the NODC BT file. A similar link is recommended between FLENUMWEACEN and NWRC in order to provide access to NWRC climatological data and to expedite the flow of naval sea surface temperature and surface meteorological data to NWRC.

FLEET WEATHER CENTRALS/FACILITIES (FLEWEACEN/FLEWEAFAC's)

Each of the Centrals and the Fleet Weather Facility, Suitland, has mission responsibility to provide required meteorological and oceanographic services within geographical areas as assigned covering the entire globe. The remaining Facilities assist the various Centrals as required, provide intensive local support to the fleet, and in many instances have functional responsibilities. In addition, certain FLEWEACEN/FLEWEAFAC's have been designated as computer centers to provide environmental data to specified tieline activities of the Naval Environmental Data Network (NEDN), encompassing an area from the Philippines to Europe.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION - EARTH RESOURCES AIRCRAFT PROGRAM (ERAP)

The work of the ERAP has been briefly described in the introductory remarks heading the present chapter. The mission of this agency is to develop instrumentation for remote sensing of phenomena related to earth resources--both in the ocean basins and on the continents. ERAP is located in the NASA Houston complex, at the Manned Spacecraft Center (MSC) and at Ellington Air Force Base. Instrumentation is now being evaluated in test flights aboard aircraft by ERAP as indicated in Table V-3.

ERAP DATA ACQUISITION PLATFORMS

The basic platform for oceanographic data collection for ERAP research is a Lockheed P-3 (Stretched Electra). This aircraft is used in many areas of the world--including the North Atlantic, operating from Ireland; the Arctic Ocean (Alaska); and areas reached from Mexican and Brazilian bases. Use of the P-3 allows missions to be flown to altitudes of 35,000 to 40,000 feet. The average utilization of the P-3 has been 24 missions per year.

For higher altitude missions, modular installations of ERAP sensors (pallettes) are installed aboard an Air Force RB-57F. This aircraft can reach 60,000 feet, at which altitude 95 percent of the atmosphere has been left below. Twelve missions per year have been flown using the RB-57.

AGENCIES PARTICIPATING IN ERAP MISSIONS

Principal investigators from the Departments of Agriculture and Interior (USGS) and the Navy are the major participants in ERAP. NAVOCEANO maintains a liaison representative at Ellington AFB. Participating agencies gather requests and proposals for investigation from within their own organization and draw up a joint program at quarterly scheduling meetings. The NASA-Earth Resources

TABLE V-3

REMOTE SENSORS PRESENTLY USED IN EARTH RESOURCES PROGRAM

CAMERAS	MICRON RANGE OR FREQUENCY	RECORDING MEDIUM	REMARKS
• WILD RC-8 MAPPING CAMERA		9.5-INCH FILM COLOR COLOR IR, BLACK & WHITE	
• ITEK 9-LENS MULTISPECTRAL CAMERA		70 MM BLACK & WHITE, BLACK & WHITE, IR FILM	USE MAY BE DISCONTINUED
• CLUSTER OF SIX HASSELBLAD CAMERAS (MULTISPECTRAL)		70 MM BLACK & WHITE, BLACK & WHITE IR FILM	
• CLUSTER OF FOUR [illegible] CAMERAS (MULTISPECTRAL)		5-INCH BLACK & WHITE, BLACK & WHITE IR FILM	
MICROWAVE			
• MR-62 & MR-64 PASSIVE MICROWAVE RADIOMETERS	9.3, 15.8, 22.2 and 34.0 GHz	1-INCH ANALOG MAGNETIC TAPE, FM RECORDED	
• MULTIFREQUENCY MICROWAVE RADIOMETER	1.42, 10.625, 22.235, 22.355 and 31.4 GHz	1-INCH ANALOG MAGNETIC TAPE, PCM RECORDED	
RADAR			
• SINGLE POLARIZED SCATTEROMETER RADAR	13.3 GHz	1-INCH ANALOG MAGNETIC TAPE	FM RECORDED ON 2 CHANNELS
• DUAL POLARIZED SCATTEROMETER RADAR	13.3 GHz	1-INCH ANALOG MAGNETIC TAPE	FM RECORDED ON 4 CHANNELS

TABLE V-3 (Cont'd)
REMOTE SENSORS PRESENTLY USED IN
EARTH RESOURCES PROGRAM

RADAR (CONT'D)	MICRON RANGE OR FREQUENCY	RECORDING MEDIUM	REMARKS
• DUAL POLARIZED SCATTEROMETER RADAR	1.6 GHz	1-INCH ANALOG MAGNETIC TAPE, SINGLE SIDEBAND MODULATED & MULTI-PLEXED	FM RECORDED ON 1 CHANNEL
• DUAL POLARIZED SCATTEROMETER RADAR	400 GHz	1-INCH ANALOG MAGNETIC TAPE, FM/FM RECORDED	1 CHANNEL
INFRARED/ULTRAVIOLET			
• RECONNOFAX IV INFRARED SCANNER	8-14 MICRONS	70 MM BLACK & WHITE FILM	
• RS-7 INFRARED SCANNER	8-15 MICRONS	70 MM BLACK & WHITE FILM	
• RS-14 DUAL CHANNEL SCANNER	3-5.5 MICRONS 8-14 MICRONS	1-INCH MAGNETIC TAPE FM RECORDED	ONE CHANNEL SELECTABLE FOR RECORDING ON BLACK & WHITE FILM
• IR SPECTROMETER	6-13 MICRONS	1-INCH MAGNETIC TAPE PCM RECORDED	IR SPECTROMETER AND RADIOMETER NORMALLY USED TOGETHER
• IR RADIOMETER	6-13 MICRONS	1-INCH MAGNETIC TAPE PCM RECORDED	
• PRT-5 (BARNES) RADIATION THERMOMETER	8-14 MICRONS	1-INCH MAGNETIC TAPE	

Division then schedules the selected missions. The Earth Resources Division attempts to make up cancelled missions (due to bad weather or unscheduled aircraft downtime) within the quarter. Oceanographic missions flown by ERAP thus serve a dual purpose of providing data for instrument development and at the same time providing useful data, subject to the caveat that it has been obtained by experimental instrumentation, to principal investigators of cooperating agencies. In addition to Federal agency participation, researchers from universities, usually under ONR or NSF contracts, also participate, particularly in the area of sea state measurement by radar scatterometer. Private industry has also cooperated in this latter connection, by furnishing oil drilling platforms for "ground truth" wave height measurements.

EARTH RESOURCES DATA BANK

The data collected in ERAP mission are archived in the MSC-Ellington AFB area, as are reports generated by principal investigators. Dissemination of these data (including photographic images) and reports is limited at present, because of the experimental nature of the sensors. Imagery produced under ERAP is stored, together with Gemini and Apollo manned-mission photography, separately at MSC by the photography laboratory. An accession list of ERAP data (strip charts and magnetic tape), photographs, and technical reports is issued semi-annually by NASA-MSC and maintained by compiling monthly supplements. Site maps and descriptions, as well as mission requests and reports, are included in this accession list. The accession list is maintained in computer-readable format and is organized by data type, geographic area (essentially Marsden squares), site number and mission number.

At present, since only principal investigators have access to the data bank, the form of the accession list is quite satisfactory. Its present organization would, in fact, not preclude its use by a wider variety of users, although such users' lack of knowledge about the characteristics of sensors and cameras specified in the file would be a drawback. As the volume of data grows

(about seven million frames of photographs have already been accumulated by the data bank) and more of the instrumentation moves out of the research and development into the operational stage, a more elaborate automated indexing system, containing more information, will be necessary. ERAP is already moving in this direction. In order to release data more widely, hard copy generators (from microfilm) will be utilized; some of these machines are already in use at MSC. ERAP is presently generating a thesaurus for search and retrieval and is contemplating the use of CRT display units and alphanumeric remote keyboards as aids in retrieval.

ERAP currently produces an impressive catalog of conventional and infrared photographs. Research is conducted by a number of principle investigators to determine the usefulness of these photos in earth resources management, e.g., forestry and crop management. Signature data such as that produced by radar scatterometers, are also available at ERAP. It may be possible to develop catalogs of signature recordings classified by terrain having certain properties. After a sufficient quantity of signature data has been classified, newly acquired signature data would be used to identify the type of terrain, such as a dense forest or open field. A catalog of this data could be used as an aid in land management.

Lack of ADP equipment is not a problem at NASA-Houston. ERAP, however, does not have the personnel to devote to development of a widely accessible data base. For this reason this development will proceed under a contract basis, and the operational system might also be handled by a contracting, probably non-profit, company. In any event, full support should be given ERAP for the purpose of increasing the accessibility of the Earth Resources Data Bank.

VI. EVALUATION OF ALTERNATIVES FOR IMPROVED MARINE DATA MANAGEMENT

RESOURCE ALLOCATION MODEL

A model has been developed and implemented on a digital computer for the purpose of evaluating alternatives for improved data management as an aid in the preparation of technical development plans. The model is used to assist in the allocation of resources to the improvement of existing products and data services and for the introduction of new products and services. The outputs of the model are product and data service performance levels and the allocation of the total marine data management budget among products and data parameter groups for each of ten years during FY 71-81. Performance levels are an index of the level of effort required in order to achieve specified improvements in existing products and services and to develop new products and services. Performance levels are pure numbers. The concept of performance levels evolved in order to satisfy the need for a universal index of performance, regardless of the type of agency activity, whether it be the production of nautical charts or the furnishing of data to users from national data centers. Performance levels are related to performance factors. Performance factors are the practical measures of product and service performance. For example, a performance level of 1.0 might be assigned to an eight week delay (performance factor) in introducing changes to Notice to Mariners; whereas, a performance level of 8.0 could be assigned to a delay of one week (performance factor).

Minimum and maximum performance levels are assigned to each product or data parameter for each of ten years. Minimum performance levels are established in order to ensure that a minimum capability in product or service performance is achieved each year. Maximum performance levels are established in order to ensure against a solution which would be infeasible in terms of available agency resources. An upper limit on the total priority marine data management budget is also established for each year for a given budget curve.

The model which has been developed can be used to determine performance levels and the allocation of funds to products and data parameter groups and to agencies for any assumed minimum and maximum performance levels, for any assumed total marine data management budget function, and for any number of years desired. The objective function of the model (the function to be maximized) is an expression which is proportional to user benefits. It is the summation of the product of performance levels and normalized unfulfilled needs scores. The latter are indices which indicate the relative degree of unfulfilled needs which exist for a given product or data parameter. Increases in performance will result in increased user benefits, if the increase in performance is directed toward the fulfillment of an unfulfilled user need. The purpose of the normalized unfulfilled needs scores in the objective function is to weight the performance levels by a measure which reflects the extent of unfulfilled needs.

A comprehensive and systematic evaluation of the inadequacies in existing products and data parameters was performed during the Part II Study. The unfulfilled needs were identified in terms of geographic coverage, accuracy, detail, timeliness and density of data collection. Unfulfilled needs were scored on an ordinal scale according to the severity of the inadequacies. By normalizing, or dividing the set of scores for a given product group by the highest score in the group, an index is produced which represents the unfulfilled needs for a given product relative to other products in the group. Thus, the number 1.0 is assigned to the product in a group with the greatest user unfulfilled needs; fractional scores represent lower user unfulfilled needs. A detailed explanation of the methodology is presented in Chapter IV of this volume. The scores represent the degree of need for improvement in a product or data parameter group at the present time. Since the model spans a period of ten years, it was necessary to take into consideration the changes in unfulfilled needs which would occur in the next ten year. The description of the method for accomplishing this is presented in a later section of this chapter.

To summarize, the outputs of the model are:

- performance levels for each priority product and data parameter for each of ten years;
- allocation of funds to each priority product and data parameter for each of ten years.

The inputs to the model are:

- minimum and maximum performance levels for each product and parameter group for each of ten years;
- an upper total budget constraint for each of ten years.
- an objective function which is proportional to user unfulfilled needs.

Budget allocations by agency are achieved by distributing the product and data parameter costs on the basis of the existing distribution of costs for a given product or parameter among agencies. This is performed after the model solution is obtained.

A feature of the model is the use of the current year's performance solution as the minimum performance level for the following year. This technique ensures a steady increase over the decade in agency performance levels.

The model is formulated in a linear programming format. Solutions for each year are optimal. As explained, outputs from one period are used as inputs in the succeeding period. A mathematical description of the model follows.

Benefit/Performance/Cost Model

1. Purpose

To maximize total yearly benefits derived from priority product/data use by optimally selecting data and product service performance levels and by optimally allocating the total yearly Federal marine data management budget among priority products and data parameter groups.

2. Objective Function

Maximization of yearly total benefits for all priority product and data parameter groups. A solution is obtained for each of the ten years FY71-FY80.

3. Solution Variable

Performance level for each product and data parameter group for each year over a ten year period.

4. Constraints

a. Budget

The total yearly budget for data management in the Federal Government must not be exceeded (one constraint).

b. Performance

(1) Minimum

A minimum performance level for each product and data parameter service must be met for each year.

(2) Maximum

A maximum performance level for each product and data parameter group service must not be exceeded for each year. This constraint is employed in order to avoid solutions of performance level which are not required and/or are infeasible (surf forecasts issued once per minute).

5. Definition of Terms

Indicies	Units	Definition
i		Product or data parameter group
t		Year
n		Number of product and data parameter groups

Solution Variable

P_{it}	Pure number	Performance level for product or data parameter service i in year t

Constraints

F_t	Dollars	Total funds (budget) available fo data management in year t
L_{it}	Pure number	Minimum (lower) performance level for product or data parameter service i in year t
M_{it}	Pure number	Maximum performance level for product or data parameter service i in year t

Other Variables

Q_{it}	Number of units	Quantity to be produced of product or data parameter group i in year t
C_{it}	Dollars	Total cost of providing product or data parameter group i in year t
B_{it}	Pure number	Potential benefits to be obtained from the use of product or data parameter group i in year t

Coefficients

Constraints

A_{it}	Dollars per performance level	Cost/Performance level ratio for product or data parameter service i in year t

Objective Function

U_{it}	Pure number (.01 to 1.0)	Normalized unfulfilled need for product or data parameter group i in year t = benefit/performance ratio (by definition).

6. Relationships

$Q = f_1\ (t)$

$C = f_2\ (Q,\ P) = A\ P,\ A = C/P$

$B = f_3\ (U,P) = U\ P.\ U = F/P$

7. Linear Programming Formulation

Maximize:

$$(1)\quad U_{1t}\ P_{1t} + U_{2t}P_{2t} + \text{----------} + U_{it}P_{it} + \ldots\ldots U_{nt}P_{nt}$$

Subject to:

$$(2)\quad A_{1t}\ P_{1t} + A_{2t}P_{2t} + \text{----------} + A_{it}P_{it} + \ldots\ldots A_{nt}P_{nt} \leq F_t$$

$$(3)\quad \begin{array}{lllll} P_{1t} & & & & \geq L_{1t} \\ & P_{2t} & & & \geq L_{2t} \\ & & P_{it} & & \geq L_{it} \\ & & & P_{nt} & \geq L_{nt} \end{array}$$

$$(4)\quad \begin{array}{lllll} P_{1t} & & & & M_{1t} \\ & P_{2t} & & & \leq M_{2t} \\ & & P_{it} & & \leq M_{it} \\ & & & P_{nt} & \leq M_{nt} \end{array}$$

(1) Maximization of Benefits

(2) Total Budget Constraint

(3) Minimum Performance Level Constraints

(4) Maximum Performance Level Constraints

Obtain a solution for each of 10 years FY 70-79. U_{it}, A_{it}, F_t, L_{it}, and M_{it} change each year.

EXISTING PRODUCTS AND DATA PARAMETER GROUPS

In order to generate the total yearly budgetary constraints which are a part of the model, cost/performance ratios, A_{it}, must be developed for each product and data parameter for each of ten years. These values are calculated as follows:

It is anticipated that the total annual cost of producing a product will grow with the number of product users. This is due to the increased production necessary in order to meet the additional demand created by the growth in the number of users.

$$A_{it} = A_{io}(1 + \alpha_i)^t; \tag{1}$$

where α_i = the annual growth rates in the number of users of the i^{th} product.

Note that for constant product or data parameter output, the cost/performance ratios would either remain constant or decrease due to the introduction of technology and improvements in data management procedures. However, for a given performance level, the total cost of production will increase with an increase in the quantity of product or parameter output. Increased quantities of product and parameter output are necessary over the decade in order to meet the needs of an expanding user population. Therefore, the total cost to performance ratio will increase over the decade.

Equation (1) is a means of generating the total cost/performance ratios for a given product i in year t. The ratios are used as coefficients in the total budget constraint inequality (2).

Two components of (1) are required: A_{io}, the present cost of producing product or data parameter i and α_i the annual growth rate in the number of users of product or parameter i. The existing product or parameter costs have been estimated for each of the priority product or parameters and are summarized in Table VI-1.

TABLE VI-1

SUMMARY OF PRESENT DATA MANAGEMENT COST
FOR PRIORITY PRODUCTS AND DATA PARAMETER GROUPS (A_{io})

PRODUCT OR DATA PARAMETER GROUP	ANNUAL DATA MANAGEMENT COSTS (EXCLUDING PLATFORM COSTS (MILLIONS OF DOLLARS)	
	AGENCY PRODUCT/DATA PARAMETER COST	TOTAL PRODUCT/DATA PARAMETER COST
ENVIRONMENTAL DESCRIPTIVE PRODUCTS		
Bathymetric Maps		0.4
Naval Oceanographic Office	0.3	
Coast and Geodetic Survey	0.1	
Ocean Station Atlases		0.5
Naval Oceanographic Office	0.49 (0.5)	
Nautical Charts		13.4
Naval Oceanographic Office	9.0	
Coast and Geodetic Survey	3.8	
Lake Survey	0.6	
Sea and Swell Atlases		0.6
Naval Oceanographic Office	0.40	
Coastal Engineering Research Center	0.2	
Surface Current Atlases		0.2
Naval Oceanographic Office	0.22 (0.2)	
Geological and Geophysical Reports and Maps		1.3
Naval Oceanographic Office	0.37 (0.4)	
U.S. Geological Survey	0.8	
Coastal Engineering Research Center	0.1	
Fishery Resource Atlases		0.3
Bureau of Commercial Fisheries	0.3	
Sportfishing Atlases		0.4
Bureau of Sportfishing and Wildlife	0.4	
Magnetic Field Maps		0.8
Naval Oceanographic Office	0.6	
Coast and Geodetic Survey	0.15 (0.2)	
Gravity Field Maps		1.1
Naval Oceanographic Office	0.9	
Coast and Geodetic Survey	0.15 (0.2)	
Sea Surface Temperature Atlases		0.1
Naval Oceanographic Office	0.06 (0.1)	
Ice Atlases		0.1
Naval Oceanographic Office	0.09 (0.1)	

[1] Differences in agency product costs should not be interpreted as differences in agency effectiveness in product preparation. These costs are not comparable due to variations in number of units of product issued and size of user communities served.

TABLE VI-1 (CON'T)

SUMMARY OF PRESENT DATA MANAGEMENT COST
FOR PRIORITY PRODUCTS AND DATA PARAMETER GROUPS (A_{1o})

PRODUCT OR DATA PARAMETER GROUP	ANNUAL DATA MANAGEMENT COSTS (EXCLUDING PLATFORM COSTS) (MILLIONS OF DOLLARS)	
	AGENCY PRODUCT/DATA PARAMETER COST	TOTAL PRODUCT/DATA PARAMETER COST
ENVIRONMENTAL DESCRIPTIVE PRODUCTS (Continued)		
Fishery Statistics Reports		0.5
Bureau of Commercial Fisheries	0.5	
Navigation Notices		0.9
Naval Oceanographic Office	0.5	
Coast and Geodetic Survey	0.04 (0.1)	
Coast Guard	0.2	
Navy (Other than Naval Oceanographic Office)	0.1	
ENVIRONMENTAL FORECASTING PRODUCTS		
Sea Surface Temperature Charts		0.3
Naval Weather Service	0.1	
Coast Guard	0.02	
Bureau of Commercial Fisheries	0.2	
Thermal Structure Forecasts		1.8
Naval Weather Service	0.26 (0.3)	
Coast Guard	1.54 (1.5)	
Extended Range Weather Forecasts		0.1
Weather Bureau	0.02 (0.05)	
Naval Weather Service	0.02 (0.05)	
Coastal Weather and Wave Forecasts		1.5
Weather Bureau	0.65 (0.7)	
Naval Weather Service	0.85 (0.8)	
Wave Height Forecasts		0.7
Weather Bureau	0.18 (0.2)	
Naval Weather Service	0.44 (0.4)	
Coast Guard	0.11 (0.1)	
Hemispheric Weather Charts		1.3
Weather Bureau	0.25 (0.2)	
Naval Weather Service	0.80 (0.9)	
Coast Guard	0.19 (0.2)	
Products Obtained from Satellite Remote Sensors		7.1
National Environmental Satellite Center	7.13 (7.1)	

[1] Differences in agency product costs should not be interpreted as differences in agency effectiveness in product preparation. These costs are not comparable due to variations in number of units of product issued and size of user communities served.

TABLE VI-1 (CON'T)

SUMMARY OF PRESENT DATA MANAGEMENT COST
FOR PRIORITY PRODUCTS AND DATA PARAMETER GROUPS (A_{io})

PRODUCT OR DATA PARAMETER GROUP	ANNUAL DATA MANAGEMENT COSTS (EXCLUDING PLATFORM COSTS) (MILLIONS OF DOLLARS)	
	AGENCY PRODUCT/DATA PARAMETER COST	TOTAL PRODUCT/DATA PARAMETER COST
ENVIRONMENTAL FORECASTING PRODUCTS (Continued)		
High Seas Weather Forecasts		0.7
Weather Bureau	0.11 (0.1)	
Naval Weather Service	0.47 (0.5)	
Coast Guard	0.10 (0.1)	
Fishery Products Reports		0.1
Bureau of Commercial Fisheries	0.1	
Surf Forecasts		0.1
Weather Bureau	0.01 (0.1)	
Oceanic Ice Forecasts		0.1
Coast Guard	0.04 (0.1)	
Tsunami Warnings		0.4
Coast and Geodetic Survey	0.4	
Tropical Cyclone Advisories		0.5
Weather Bureau	0.03	
Naval Weather Service	0.47	
Storm Surge Advisories		0.1
Weather Bureau	0.01 (0.1)	
Estuarine Flushing Predictions		0.1
Coast and Geodetic Survey	0.1	
Fishery Advisories		0.1
Bureau of Commercial Fisheries	0.1	
DATA PARAMETER GROUPS		
Pressure, Temperature and Density		1.30
National Oceanographic Data Center	1.17	
Environmental Data Service	0.08	
Great Lakes Regional Data Center	0.05	
Currents		0.50
National Oceanographic Data Center	0.50	
Tides		0.15
Great Lakes Regional Data Center (Lake Levels)	0.15	

[1]Differences in agency product costs should not be interpreted as differences in agency effectiveness in product preparation. These costs are not comparable due to variations in number of units of product issued and size of user communities served.

TABLE VI-1 (CON'T)

SUMMARY OF PRESENT DATA MANAGEMENT COST
FOR PRIORITY PRODUCTS AND DATA PARAMETER GROUPS (A_{io})

PRODUCT OR DATA PARAMETER GROUP	ANNUAL DATA MANAGEMENT COSTS (EXCLUDING PLATFORM COSTS) (MILLIONS OF DOLLARS)	
	AGENCY PRODUCT/DATA PARAMETER COST	TOTAL PRODUCT/DATA PARAMETER COST
DATA PARAMETER GROUPS (Continued)		
Waves		0.30
Environmental Data Service	0.30	
Salinity		0.48
National Oceanographic Data Center	0.48	
Dissolved Gases		0.29
National Oceanographic Data Center	0.29	
Rock or Sediment Samples		0.01
Smithsonian Oceanographic Sorting Center	0.01	
Rock or Sediment Descriptions		0.06
National Oceanographic Data Center	0.05	
Smithsonian Oceanographic Sorting Center	0.01	
Specimen Holdings (biological)		0.18
Smithsonian Oceanographic Sorting Center	0.18	
Taxonomic Position		0.20
Smithsonian Oceanographic Sorting Center	0.20	
Collection Data (biological)		0.01
National Oceanographic Data Center	0.01	
Air Characteristics		0.52
Environmental Data Service	0.52	
Winds		0.11
Environmental Data Service	0.11	
Clouds		0.16
Environmental Data Service	0.16	
TOTAL		39.9

[1]Differences in agency product costs should not be interpreted as differences in agency effectiveness in product preparation. These costs are not comparabel due to variations in number of units of product issued and size of user communities served.

These are the FY 70 costs. The costs are shown by product/data parameter and by producing agency. Equation (1) is used to generate product/data parameter costs (A_{it}) for each succeeding year, using the A_{io} shown in Table VI-1 as the reference (FY 70) costs. A performance level of 1.0 is used as the reference performance level for FY 71 in the model.

Annual growth rates α_i in product demand are determined by computing a weighted average of the growth rate in user community populations which use a given product. The weights are the estimated share of product usage among the user groups. Rates of growth of several user communities are shown in Figures VI-1 through VI-6. In certain communities, such as naval operations, the determination of rate in growth of the number of users is derived from other factors, such as the rate of growth in number of navy commissioned ships.

The calculation of product demand growth rates is shown in Table VI-2. The results of the calculation of the yearly product costs (A_{it}) are shown in Table VI-3.

The next factor which is required in the model are the normalized unfulfilled needs scores (U_{it}) which are the coefficients of the objective function (user benefit function). As mentioned previously, these values are a quantification of the unfulfilled needs for a given product or data parameter. They are used as weighting factors (coefficients) in the objective function of the model. In obtaining a solution, the model maximizes the sum of user benefits in a given year for all priority products and parameters. Since the unfulfilled needs for products and data will change over the decade, it is necessary to derive the U_{it} for each product and data parameter for each of 10 years. This is performed by modifying the normalized unfulfilled needs score to reflect changes in Federal budget priorities for major user activities (e.g., fishing) over the next ten years. The rationale for this approach is that changes in the Federal budget will reflect changes in user needs (at least approximately). The calculation of U_{it} for products is given below.

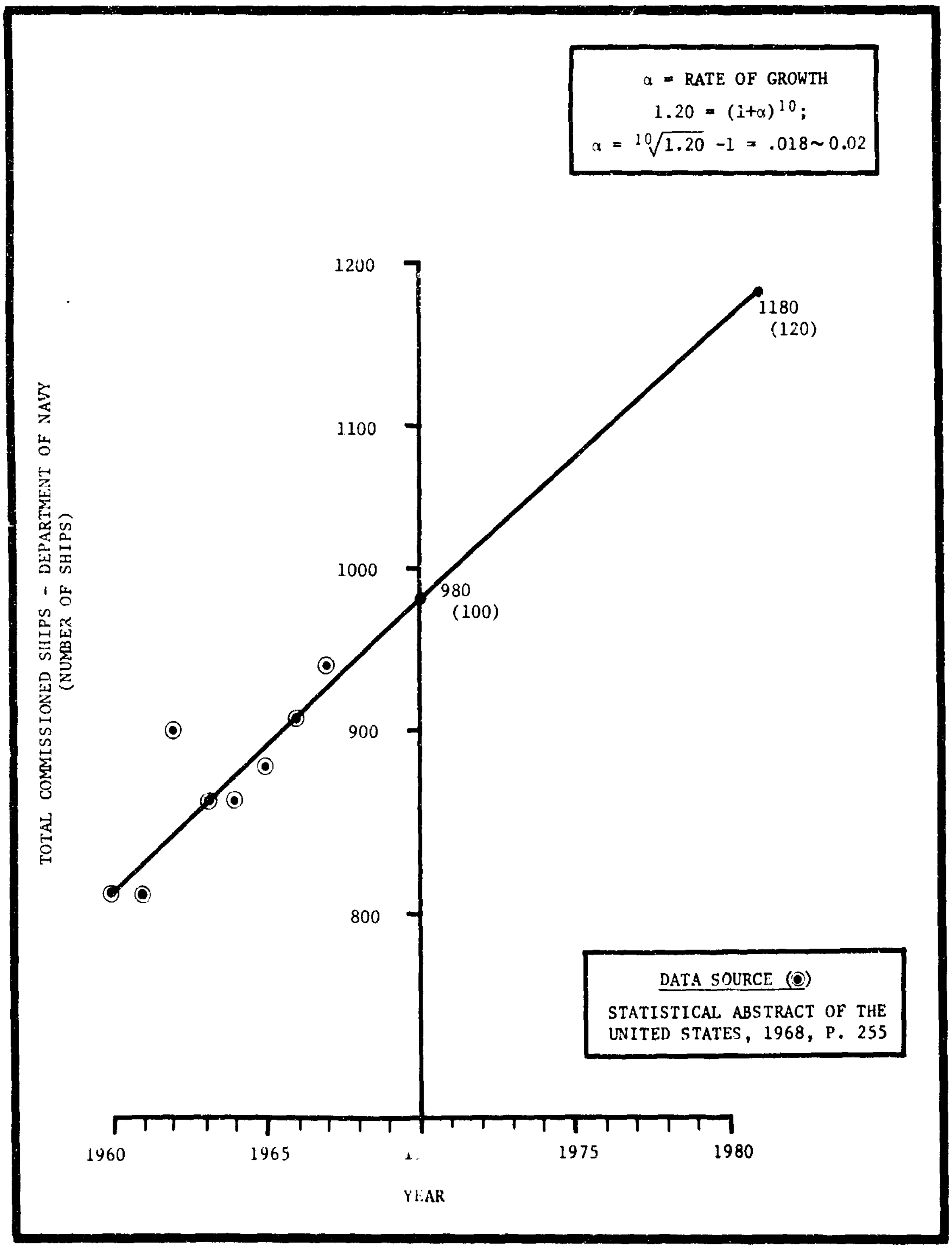

FIGURE VI-1. DETERMINATION OF RATE OF GROWTH FOR NAVAL OPERATIONS

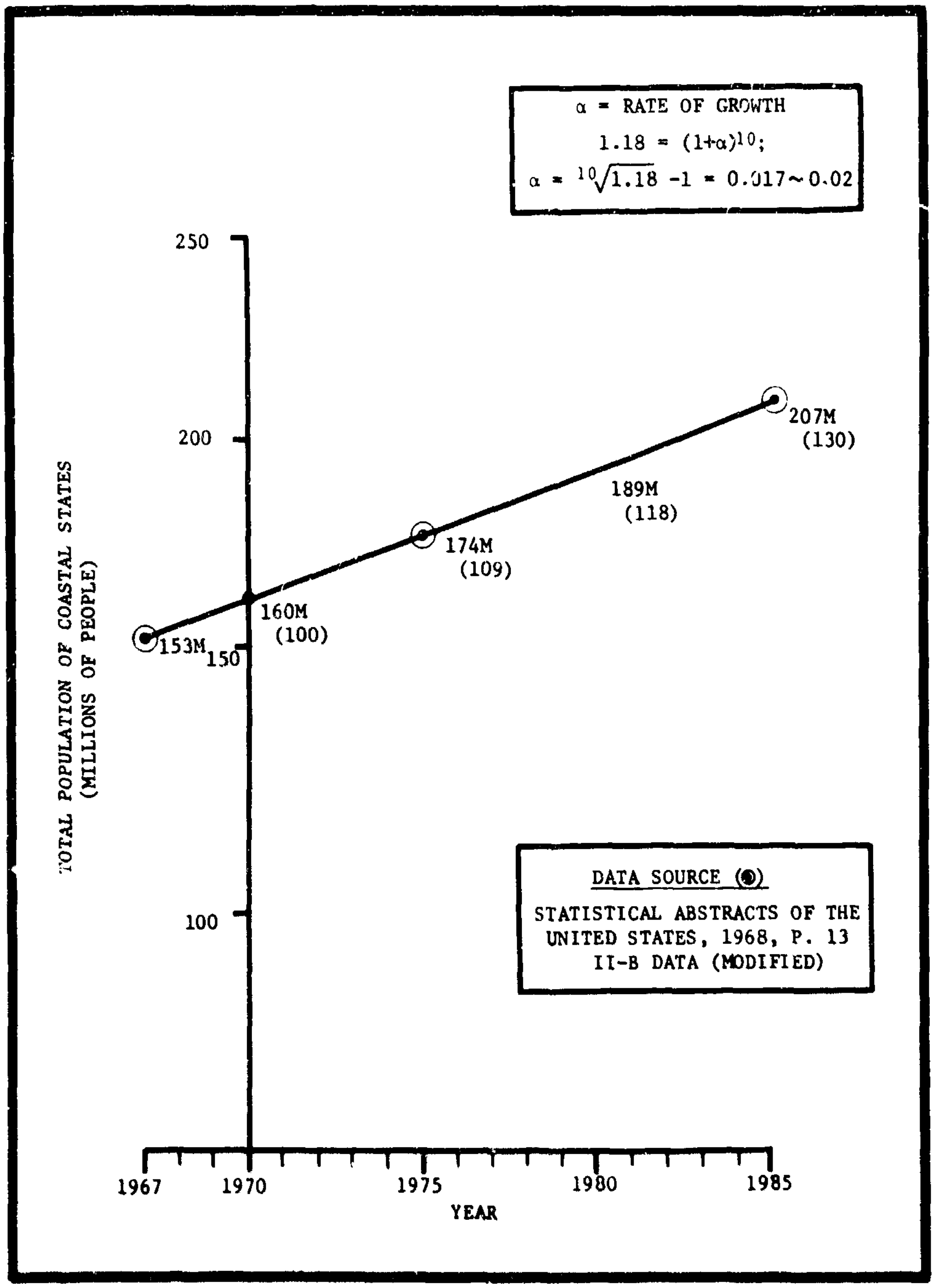

FIGURE VI-2. DETERMINATION OF RATE OF GROWTH FOR ENVIRONMENTAL FORECASTING AND RESOURCE MANAGEMENT

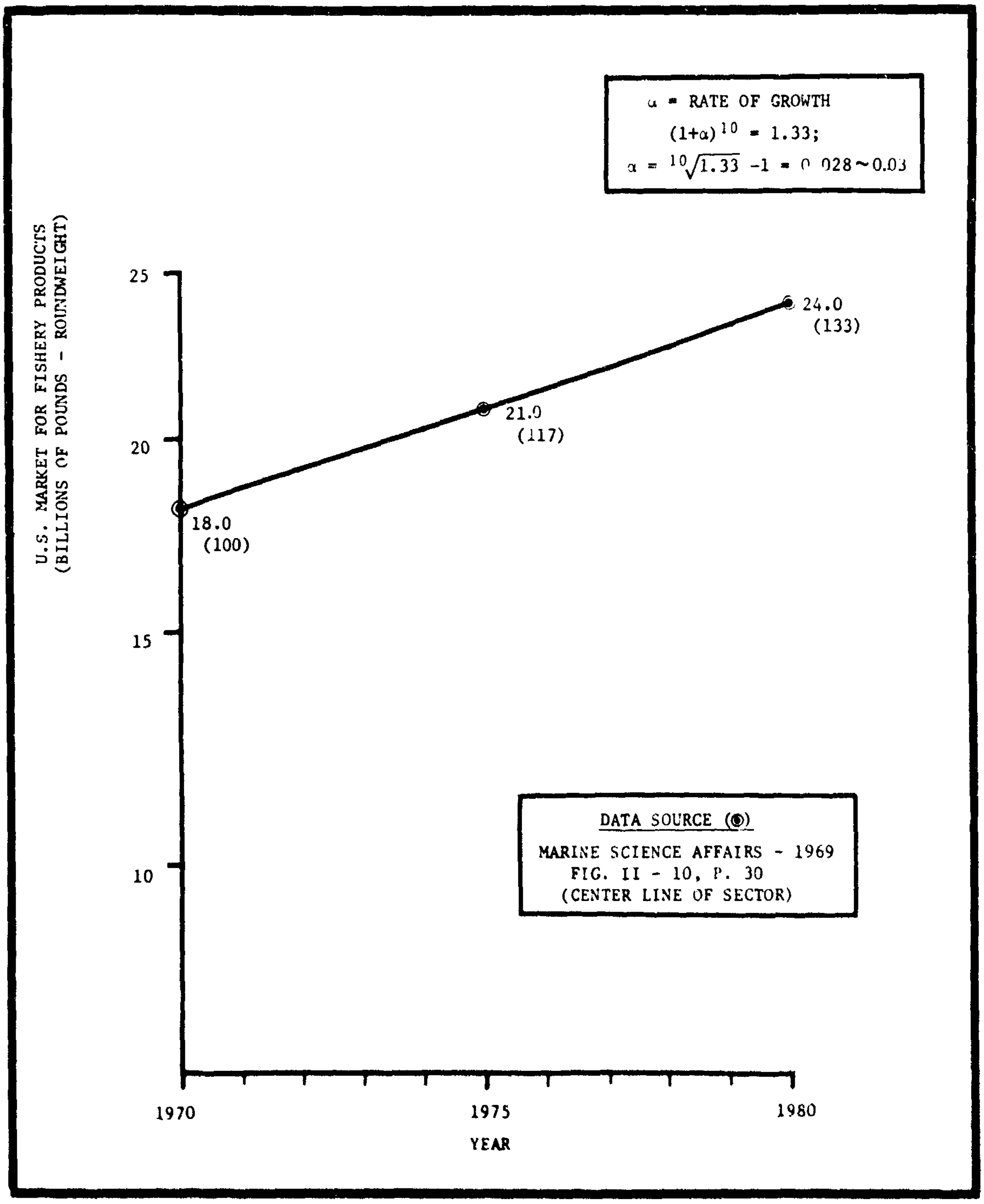

FIGURE VI-3. DETERMINATION OF RATE OF GROWTH OF FISHING

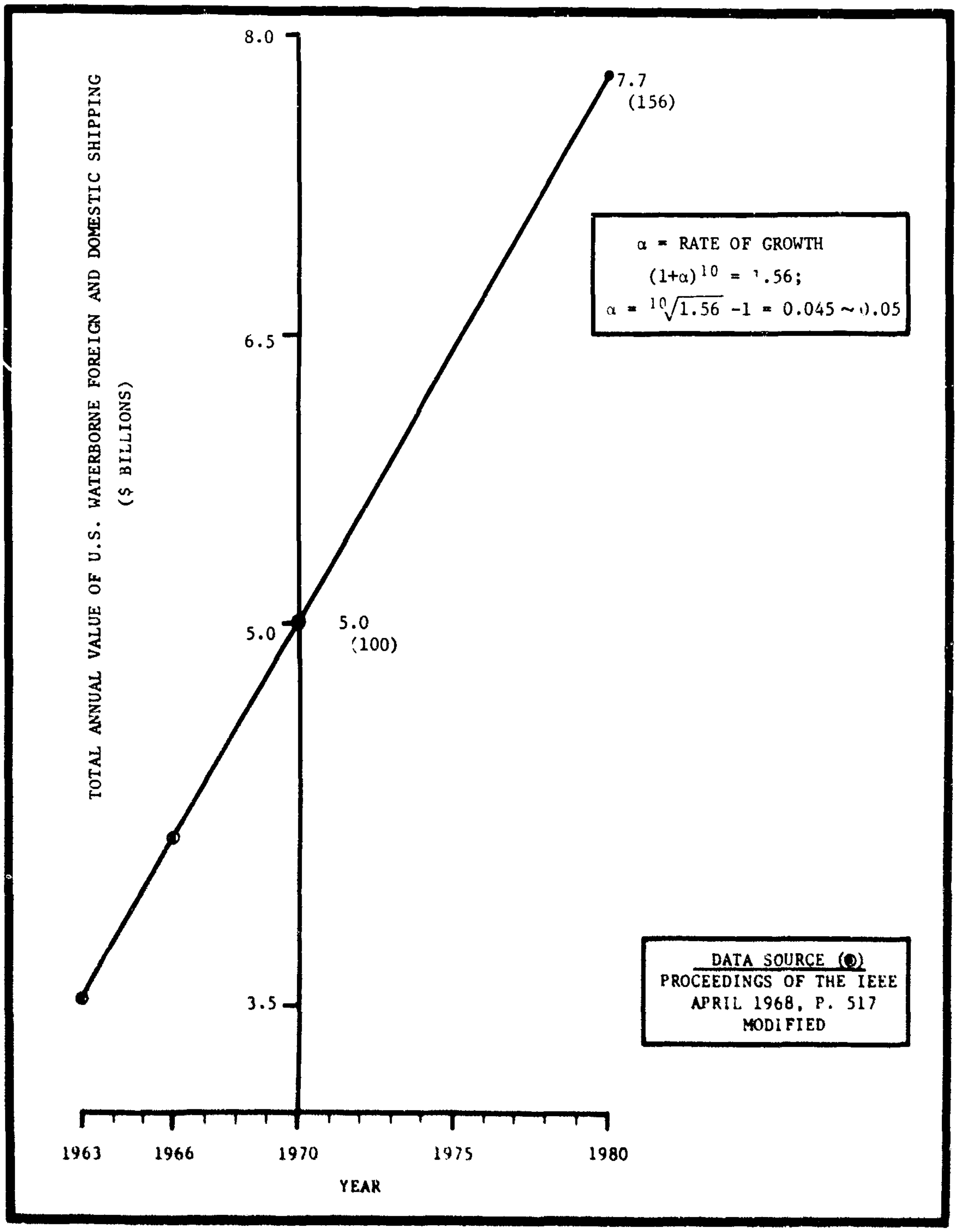

FIGURE VI-4. DETERMINATION OF RATE OF GROWTH OF MERCHANT SHIPPING

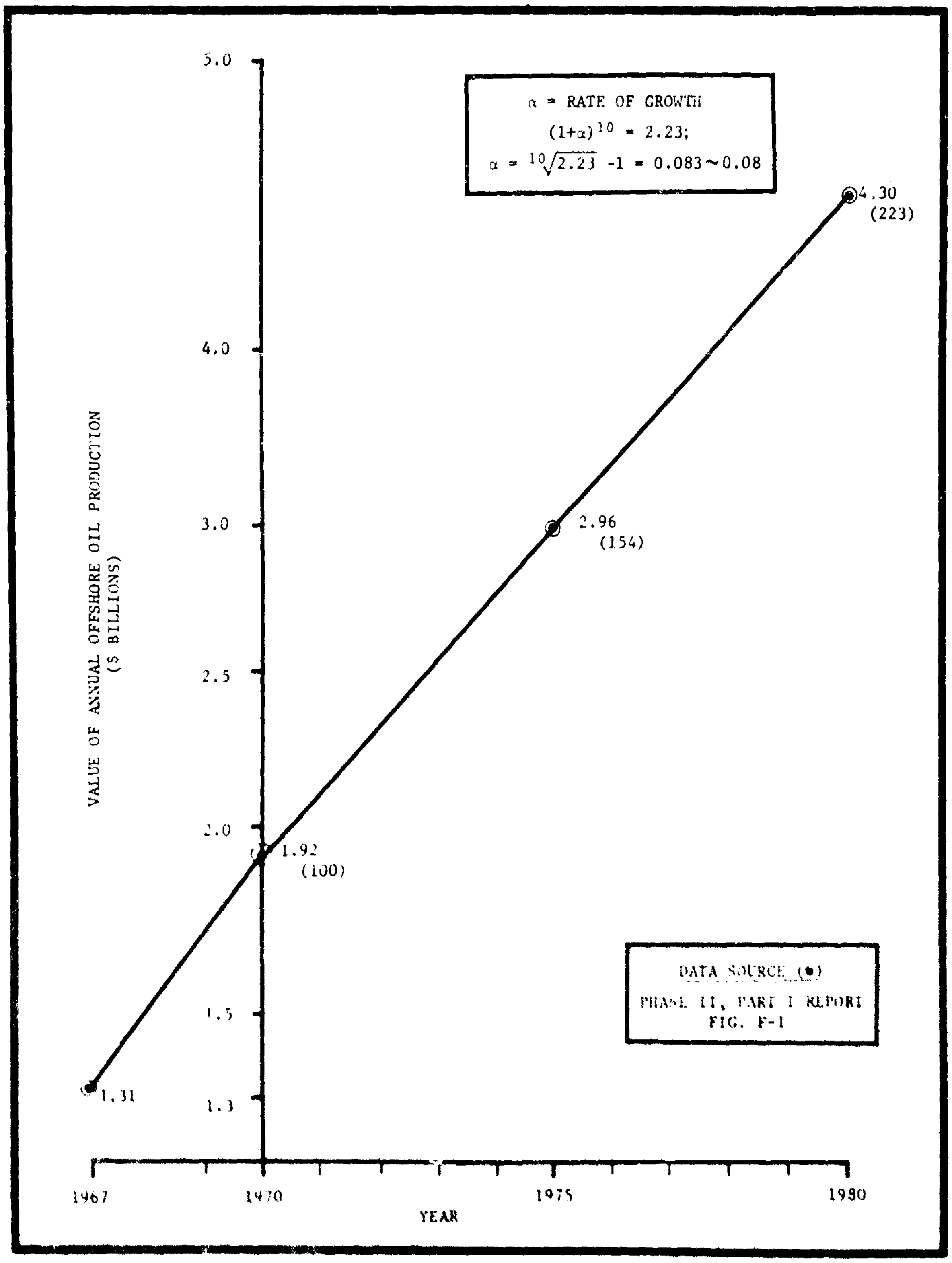

FIGURE VI-5. DETERMINATION OF RATE OF GROWTH OF INDUSTRIAL OPERATIONS

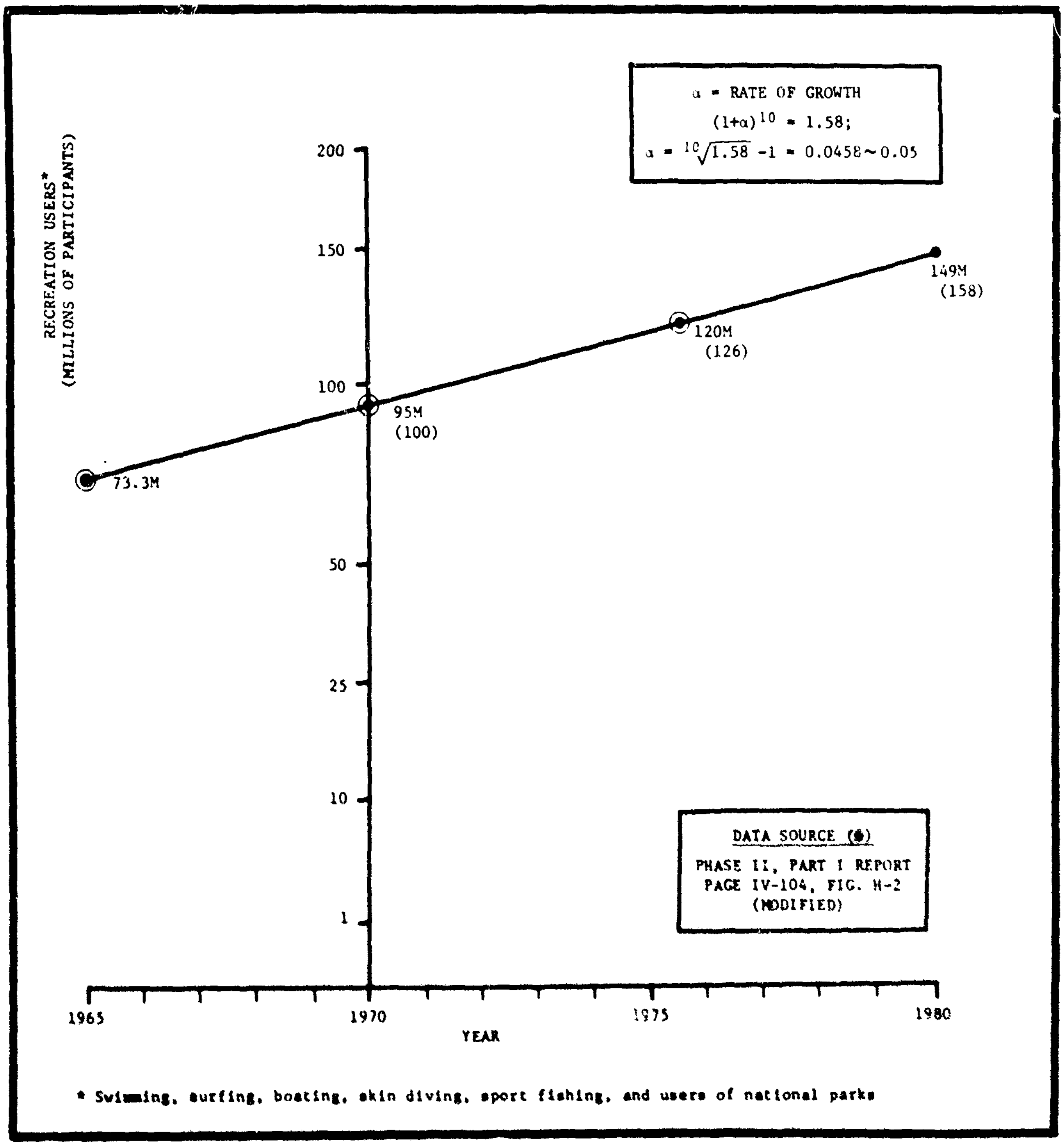

FIGURE VI-6. DETERMINATION OF RATE OF GROWTH OF MARINE RECREATION IN THE UNITED STATES

TABLE VI-2

ESTIMATION OF THE RATE OF INCREASE OF DEMAND (α) FOR PRIORITY PRODUCTS

PRODUCT \ USER ACTIVITY	NAVAL OPERATIONS (0.02)*	ENVIRONMENTAL FORECASTING (0.02)	FISHING (0.03)	MERCHANT SHIPPING (0.05)	OCEAN ENGINEERING (0.08)	INDUSTRIAL OPERATIONS (0.08)	RESOURCE MANAGEMENT (0.02)	RECREATION (0.05)	PRODUCT-DEMAND GROWTH RATE (α)**
ENVIRONMENTAL FORECASTING PRODUCTS									
SEA SURFACE TEMPERATURE CHART	1/3***	1/3	1/3						0.02
THERMAL STRUCTURE FORECAST	3/4	1/8	1/8						0.02
EXT. RANGE WEATHER FORECAST	1/3			1/3		1/3			0.05
COASTAL WEATHER AND WAVE FORECAST	1/3					1/3		1/3	0.05
WAVE HEIGHT FORECAST	1/2			1/2					0.04
HEMISPHERIC WEATHER CHART	1/6	2/3		1/6					0.03
PRODUCTS OBTAINED FROM SATELLITE REMOTE SENSORS									0.02
HIGH SEAS WEATHER FORECAST	1/2			1/2					0.04
FISHERY PRODUCTS REPORT			1						0.03
SURF FORECAST						1/2		1/2	0.07
OCEANIC ICE FORECAST	1								0.02
TSUNAMI WARNING						1/3	1/3	1/3	0.05
TROPICAL CYCLONE ADVISORY						3/8	3/8	1/4	0.05
STORM SURGE ADVISORY						1/3	1/3	1/3	0.05
ESTUARINE FLUSHING PREDICTION							1		0.02
FISHERY ADVISORY			1						0.03
INLAND LAKES AND ICE FORECAST				1/3		1/3	1/6	1/6	0.06
ENVIRONMENTAL DESCRIPTION PRODUCTS									
BATHYMETRIC MAP	1/3				1/6	1/3	1/6		0.04
OCEAN STATION ATLAS	7/8	1/6							0.02
NAUTICAL CHART	1/4		[illegible]	[illegible]		1/8		1/4	0.04
CLIMATOLOGICAL ATLAS	1/5	1/5			1/5	1/5	1/5		0.04
SEA AND SWELL ATLAS	1/5			[illegible]	1/5	1/5	1/5		0.05
SURFACE CURRENT ATLAS	1/2	1/12		[illegible]	[illegible]				0.03
GEOLOGICAL AND GEOPHYSICAL REPORT AND MAP						[illegible]	[illegible]		[illegible]
FISHERY RESOURCE ATLAS			1/2				1/2		[illegible]
SPORT FISHING ATLAS			[illegible]				[illegible]	[illegible]	0.04
MAGNETIC FIELD MAP						1			0.08
GRAVITY FIELD MAP						1			0.08
SEA SURFACE TEMPERATURE ATLAS	1/2	[illegible]	[illegible]						[illegible]
ICE ATLAS	2/9	2/9		[illegible]	2/9	2/9			[illegible]
FISHERY STATISTICS REPORT									0.03
NAVIGATION NOTICE	2/3			[illegible]		[illegible]		[illegible]	[illegible]

* Annual growth rate of user activity.

** Product-demand rate of increase (α) equals the sum of the usage-weighted user-activity growth rates.

*** Values are the estimated share of product usage among the major users

TABLE VI-3

PROJECTED DATA MANAGEMENT COSTS FOR PRESENT PERFORMANCE LEVELS - PRIORITY PRODUCTS

PRODUCT	ENVIRONMENTAL DESCRIPTIVE PRODUCTS ($ MILLIONS)									
	FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79	FY 80
BATHYMETRIC MAP	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.6
OCEAN STATION ATLAS	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6
NAUTICAL CHART	13.4	13.9	14.5	15.1	15.6	16.3	16.9	17.6	18.3	19.0
SEA AND SWELL ATLAS	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9
SURFACE CURRENT ATLAS	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
GEOLOGICAL & GEOPHYSICAL REPORT & MAP	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.4
FISHERY RESOURCE ATLAS	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4
SPORTFISHING ATLAS	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6
MAGNETIC FIELD MAP	0.8	0.9	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6
GRAVITY FIELD MAP	1.1	1.2	1.3	1.4	1.5	1.6	1.8	1.9	2.0	2.2
SEA SURFACE TEMPERATURE ATLAS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
ICE ATLAS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
FISHERY STATISTICS REPORT	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7
NAVIGATION NOTICE	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.1
TOTALS ($ MILLIONS)	20.6	21.4	22.3	23.4	24.4	25.6	26.7	27.8	29.3	30.8

TABLE VI-3 (CON'T)

PROJECTED DATA MANAGEMENT COSTS FOR PRESENT PERFORMANCE LEVELS - PRIORITY PRODUCTS

PRODUCT	ENVIRONMENTAL FORECASTING PRODUCTS ($ MILLIONS)									
	FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79	FY 80
SEA SURFACE TEMPERATURE CHART	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
THERMAL STRUCTURE FORECAST	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.0	2.1	2.1
EXTENDED RANGE WEATHER FORECAST	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
COASTAL WEATHER & WAVE FORECAST	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3
WAVE HEIGHT FORECAST	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1.0
HEMISPHERIC WEATHER CHART	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.6	1.6	1.7
PRODUCTS OBTAINED FROM SATELLITE REMOTE SENSORS	7.1	7.2	7.4	7.5	7.7	7.8	8.0	8.1	8.3	8.4
HIGH SEAS WEATHER FORECAST	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1.0
FISHERY PRODUCTS REPORT	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SURF FORECAST	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
OCEANIC ICE FORECAST	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TSUNAMI WARNING	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6
TROPICAL CYCLONE ADVISORY	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8
STORM SURGE ADVISORY	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ESTUARINE FLUSHING PREDICTION	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
FISHING ADVISORY	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TOTALS ($ MILLIONS)	15.0	15.2	16.0	16.2	16.6	16.9	17.6	18.0	18.4	19.1

Determination of U_{it} for Products

The U_{it} were computed on the basis of the proportion of the Federal budget associated with each user-activity. This proportion is called the budget priority for each user-activity. This budget priority is expected to change over the next ten years. Hence, the U_{it} will be modified during these ten years. This modification can be approximated by:

$$U_{it} = U_i \ (1 + \beta_i)^t, \tag{2}$$

where β_i is the rate of change of priority for the ith product.

The determination of β_i is similar to the determination of α_i. The rate of change of priority for the ith product is the average of the rates of change of priority of each of the user activities having major unfulfilled needs for the ith product.

$$\beta_i = \sum_j b_{ij} \beta_j;$$

$$1 = \sum_j b_{ij}$$

i = i^{th} product

j = j^{th} user-activity

b_{ij} = o for user-activities which do not have major unfulfilled needs for the i^{th} product

b_{ij} = $\frac{1}{n}$ where 'n' is the number of user-activities with major unfulfilled needs.

β_j = rate of change of priority for the j^{th} user-activity.

Table VI-4 shows the determination of the rate of change of Federal budget priority for each user-activity. Table VI-5 shows the estimation of the rate of change of unfulfilled needs for priority products. The normalized unfulfilled needs scores obtained by the application of (2) are shown in Table VI-6 for priority products.

Determination of Cost Performance Ratios and Normalized Unfulfilled for Data Parameter Groups

Cost/performance ratios A_{it} and normalized unfulfilled U_{it} needs scores must also be calculated for data parameters. The explanation of this procedure follows.

The A_{it} and U_{it} determination for data parameter groups is similar to the determination of these values for products $A_{it} = A_{it=o} (1 + \alpha_i)^t$ and $U_{it} = U_{it=o} (1 + \beta_i)^t$. However, for data parameters, the growth rates (α_i) and rates of change (β_i) are based solely on the use of the data parameter groups in products.

The growth rate and the rate of change for each data parameter group is the average of the weighted growth rates and weighted rates of change, respectively, for the products. The weights are estimates of the proportion of usage of the data parameter group among the products. Here only, the subscript "k" replaces "i" for products.

$$\alpha_i = \sum_k a_{ik} \alpha_k,$$

$$\beta_i = \sum_k a_{ik} \beta_k,$$

$$1 = \sum_k a_{ik};$$

TABLE VI-4

DETERMINATION OF THE RATE OF CHANGE OF FEDERAL BUDGETARY PRIORITY FOR EACH USER ACTIVITY

USER-ACTIVITY	PRESENT BUDGET PRIORITY*	PROJECTED BUDGET PRIORITY*	RATIO	RATE OF CHANGE OF BUDGETARY PRIORITY
	1970 (%)	1980 (%)	1980(%)/1970(%)	$\sqrt[10]{\text{Ratio}} - 1$
Naval Operations	33	23	0.605	-0.0497 ∿ -0.05
Environmental Forecasting	6	9	1.5	0.041 ∿ +0.04
Fishing	10	18	1.8	0.060 ∿ +0.06
Merchant Shipping	4	4	1.0	0.00 ∿ +0.00
Ocean Engineering	13	15	1.15	0.0130 ∿ +0.01
Industrial Operations	2	5	2.5	0.0955 ∿ +0.10
Resource Management	1	3	3.0	0.122 ∿ +0.12
Recreation	1	1	1.0	0.00 ∿ +0.00

*The percentages are present and future estimates of the allocation of the Federal marine budget to marine activities.

TABLE VI-5

ESTIMATION OF THE RATE OF CHANGE OF UNFULFILLED NEEDS (β) FOR PRIORITY PRODUCTS

PRODUCT \ USER ACTIVITY	NAVAL OPERATIONS (-0.05)*	ENVIRONMENTAL FORECASTING (+0.04)	[illegible]	[illegible] SHIPPING [illegible]	OCEAN ENGINEERING (+0.21)	INDUSTRIAL OPERATIONS (+0.10)	RESOURCE MANAGEMENT (+0.12)	RECREATION (+0.00)	RATE OF CHANGE GROWTH RATE (β)**
ENVIRONMENTAL FORECASTING PRODUCTS									
SEA SURFACE TEMPERATURE CHART		1/2***	[illegible]						+0.05
THERMAL STRUCTURE FORECAST		1							+0.04
EXT. RANGE WEATHER FORECAST	1/2			[illegible]					-0.02
COASTAL WEATHER AND WAVE FORECAST						1			+0.10
WAVE HEIGHT FORECAST				1					+0.00
HEMISPHERIC WEATHER CHART		1							+0.04
PRODUCTS OBTAINED FROM SATELLITE REMOTE SENSORS		1							+0.04
HIGH SEAS WEATHER FORECAST				1					+0.00
FISHERY PRODUCTS REPORT			[illegible]						+0.06
SURF FORECAST						1/2		1/2	+0.05
OCEANIC ICE FORECAST	1								-0.05
TSUNAMI WARNING								1	+0.00
TROPICAL CYCLONE ADVISORY						1			+0.10
STORM SURGE ADVISORY						1			+0.10
ESTUARINE FLUSHING PREDICTION							1		+0.12
FISHERY ADVISORY			[illegible]						+0.06
INLAND LAKES AND ICE FORECAST				1					+0.00
ENVIRONMENTAL [illegible] PRODUCTS									
BATHYMETRIC MAP	1/4				1/4	1/4	1/4		+0.04
OCEAN STATION ATLAS	1/2	1/2							+0.00
NAUTICAL CHART	1/3					1/3		1/3	+0.02
CLIMATOLOGICAL ATLAS	1/5	1/5			1/5	1/5	1/5		+0.04
SEA AND SWELL ATLAS	1/5	1/5			1/5	1/5	1/5		+0.04
SURFACE CURRENT ATLAS	[illegible]	[illegible]			[illegible]				+0.02
GEOLOGICAL AND GEOPHYSICAL REPORT AND MAP						1/2	1/2		+0.11
FISHERY RESOURCE ATLAS							1		+0.09
SPORT FISHING ATLAS							1/3	1/3	+0.06
MAGNETIC FIELD MAP						1			+0.10
GRAVITY FIELD MAP						1			+0.10
SEA SURFACE TEMPERATURE ATLAS		1/2							+0.05
ICE ATLAS	1/5	1/5		1/5	1/5	1/5			+0.02
FISHERY STATISTICS REPORT									+0.06
NAVIGATION NOTICE	1/5			[illegible]	1/5	1/5		1/5	+0.01

* Annual rate of change of federal budgetary [illegible] activity.

** Rate of change rate of increase [illegible] equals [illegible] rate of change.

*** Entries are made only for user activities [illegible] needs.

TABLE VI-6

PROJECTED NORMALIZED UNFULFILLED NEEDS SCORES

	ENVIRONMENTAL FORECASTING PRODUCTS									
	FY71	FY72	FY73	FY74	FY75	FY76	FY77	FY78	FY79	FY80
Sea Surface Temperature Chart	0.64	0.67	0.71	0.74	0.78	0.82	0.86	0.90	0.95	0.99
Thermal Structure Forecast	0.59	0.61	0.64	0.66	0.69	0.71	0.74	0.77	0.80	0.83
Extended Range Weather Forecast	0.67	0.67	0.66	0.66	0.65	0.65	0.64	0.63	0.63	0.62
Coastal Weather and Wave Forecast	0.52	0.57	0.63	0.69	0.76	0.84	0.92	1.02	1.12	1.23
Wave Height Forecast	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hemispheric Weather Chart	0.52	0.54	0.56	0.58	0.61	0.63	0.65	0.68	0.70	0.73
Products Obtained from Satellite Remote Sensors	0.29	0.30	0.31	0.32	0.34	0.35	0.36	0.38	0.39	0.41
High Seas Weather Forecast	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Fishery Products Report	0.56	0.59	0.63	0.66	0.70	0.74	0.78	0.83	0.88	0.91
Surf Forecast	0.49	0.51	0.54	0.57	0.59	0.62	0.65	0.69	0.72	0.75
Oceanic Ice Forecast	0.41	0.40	0.39	0.38	0.37	0.36	0.35	0.34	0.33	0.32
Tsunami Warning	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Tropical Cyclone Advisory	0.57	0.63	0.69	0.76	0.84	0.92	1.01	1.11	1.22	1.34
Storm Surge Advisory	0.33	0.36	0.40	0.44	0.48	0.53	0.58	0.64	0.71	0.78
Estuarine Flushing Prediction	0.13	0.15	0.16	0.18	0.20	0.23	0.26	0.29	0.32	0.36
Fishery Advisory	0.12	0.13	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20

TABLE VI-6 CONTINUED

PROJECTED NORMALIZED UNFULFILLED NEEDS SCORES

	ENVIRONMENTAL DESCRIPTION PRODUCTS									
	FY71	FY72	FY73	FY74	FY75	FY76	FY77	FY78	FY79	FY80
Bathymetric Map	1.00	1.04	1.08	1.13	1.17	1.22	1.26	1.32	1.37	1.42
Ocean Station Atlas	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Nautical Chart	0.42	0.43	0.44	0.45	0.45	0.46	0.47	0.48	0.49	0.50
Climatological Atlas	0.41	0.42	0.44	0.46	0.48	0.50	0.51	0.54	0.56	0.58
Wave and Swell Chart	0.41	0.42	0.44	0.46	0.48	0.50	0.51	0.54	0.56	0.58
Surface and Current Chart	0.30	0.31	0.31	0.31	0.32	0.32	0.33	0.34	0.35	0.35
Geological and Geophysical Report and Map	0.30	0.33	0.37	0.41	0.45	0.50	0.56	0.62	0.69	0.76
Fishery Resource Atlas	0.24	0.26	0.29	0.31	0.34	0.37	0.41	0.44	0.48	0.53
Sportfishing Atlas	0.24	0.25	0.27	0.28	0.30	0.32	0.34	0.36	0.38	0.40
Magnetic Field Map	0.20	0.22	0.24	0.26	0.29	0.32	0.35	0.39	0.43	0.47
Gravity Field Map	0.20	0.22	0.24	0.26	0.29	0.32	0.35	0.39	0.43	0.47
Sea Surface Temperature Chart	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.28	0.29
Ice Atlas	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19
Fishery Statistics Report	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15
Navigation Notice	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Where a_{ik} is the proportion of usage of the i^{th} data parameter group in the k^{th} product. Table VI-7 shows the results of the calculation of data parameter costs A_{it} and Table VI-8 shows the results of the calculation of normalized unfulfilled needs scores for data parameters.

"NEW" PRODUCTS AND DATA PARAMETER GROUPS

Data Management Costs for "New" Products and Data Parameter Groups

An annual data management budget of $0.05 million ($50,000) is estimated to be necessary for the production of each "new" product or data parameter group. This amount is needed initially to develop a "new" product or data base and eventually to maintain the product or data base after it becomes established. Table VI-9 indicates the initial annual data management costs for "new" products and data parameter groups.

Some of the "new" products and data parameter groups are new only for a particular agency. They are priority products and data parameter groups for other agencies. These are bathymetric maps (Lake Survey); sea and swell atlases (Lake Survey); climatological atlases (Environmental Data Service as producer rather than data supplier) pressure, temperature, and density (Great Lakes Regional Data Center); and rock and sediment descriptions (National Oceanographic Data Center).

The cost of producing products and data parameter groups which are new to a particular agency can be included by adding the $.05 million increment to the present cost of producing products and data parameters. Table VI-9 shows the added increment of cost required for "new" product preparation.

Table VI-10 shows the revised projected data management costs for these "new" products.

TABLE VI-7

PROJECTED DATA MANAGEMENT COSTS FOR PRESENT PERFORMANCE LEVELS - PRIORITY DATA PARAMETER GROUPS

DATA PARAMETER GROUP	DATA PARAMETER GROUPS ($ MILLIONS)									
	FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79	FY 80
PHYSICAL										
PRESSURES, TEMPERATURES & DENSITY	1.30	1.35	1.40	1.46	1.52	1.57	1.63	1.70	1.76	1.84
CURRENTS	0.50	0.51	0.53	0.55	0.56	0.58	0.59	0.61	0.63	0.65
TIDES	0.15	0.16	0.16	0.17	0.17	0.18	0.19	0.20	0.20	0.21
WAVES	0.30	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44	0.46
CHEMICAL										
SALINITY	0.49	0.48	0.50	0.51	0.52	0.53	0.54	0.55	0.56	0.57
DISSOLVED GASES	0.29	0.30	0.30	0.31	0.31	0.32	0.33	0.33	0.34	0.34
GEOLOGICAL & GEOPHYSICAL										
ROCK OR SEDIMENT SAMPLES	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
ROCK OR SEDIMENT DESCRIPTION	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09
BIOLOGICAL & FISHERY										
SPECIMEN HOLDINGS	0.18	0.19	0.19	0.20	0.20	0.21	0.21	0.22	0.23	0.23
TAXONOMIC POSITION	0.20	0.21	0.21	0.22	0.22	0.23	0.24	0.24	0.25	0.26
COLLECTION DATA	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
METEOROLOGICAL										
AIR CHARACTERISTICS	0.52	0.54	0.56	0.58	0.60	0.63	0.65	0.68	0.70	0.73
WINDS	0.11	0.11	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.16
CLOUDS	0.16	0.17	0.17	0.18	0.19	0.20	0.20	0.21	0.22	0.23
TOTALS ($ MILLIONS)	4.26	4.27	4.56	4.73	4.87	5.06	5.22	5.41	5.60	5.80

TABLE VI-8

PROJECTED NORMALIZED UNFULFILLED NEEDS SCORES

DATA PARAMETER GROUP	ENVIRONMENTAL FORECASTING PRODUCTS - DATA PARAMETER GROUPS									
	FY71	FY72	FY73	FY74	FY75	FY76	FY77	FY78	FY79	FY80
Physical										
Pressure, Temperature and Density	0.57	0.59	0.61	0.64	0.66	0.69	0.71	0.74	0.77	0.80
Currents	0.38	0.40	0.42	0.44	0.46	0.48	0.51	0.53	0.56	0.58
Tides	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.27	0.28	0.29
Waves	0.70	0.73	0.77	0.81	0.85	0.89	0.93	0.98	1.03	1.08
Chemical										
Salinity	0.53	0.54	0.54	0.55	0.55	0.56	0.56	0.57	0.57	0.58
Dissolved Gases	0.38	0.39	0.40	0.41	0.43	0.44	0.45	0.47	0.48	0.49
Geological & Geophysical										
Rock or Sediment Samples	0.70	0.76	0.82	0.88	0.95	1.03	1.11	1.20	1.30	1.40
Rock or Sediment Description	1.00	1.08	1.17	1.26	1.36	1.47	1.59	1.72	1.86	2.02
Biological and Fishery										
Specimen Holdings	0.32	0.35	0.38	0.41	0.45	0.49	0.54	0.59	0.64	0.70
Taxonomic Position	0.12	0.13	0.14	0.16	0.17	0.19	0.20	0.22	0.24	0.26
Collection Data	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
Meteorological										
Air Characteristics	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.20
Winds	0.61	0.64	0.66	0.68	0.71	0.74	0.77	0.80	0.83	0.86
Clouds	0.53	0.54	0.55	0.56	0.57	0.58	0.59	0.61	0.62	0.63

TABLE VI-9

INCREMENTS IN ANNUAL DATA MANAGEMENT COSTS
REQUIRED FOR "NEW" PRODUCTS AND DATA PARAMETFR GROUPS

PRODUCT OR DATA PARAMETER GROUP	Annual Data Management Costs (Excluding Platform Costs) (millions of dollars)	
	Agency Cost	Total Cost
"New" Environmental Descriptive Products		
Bathymetric Maps		0.05
Lake Survey	0.05	
Coastal Station Atlases		0.05
Coast and Geodetic Survey	0.05	
Great Lakes Station Atlases		0.05
Lake Survey	0.05	
Climatological Atlases (Coastal)		0.05
Environmental Data Service	0.05	
Sea-Air Energy Exchange Atlases		0.05
Environmental Data Service	0.05	
Sea and Swell Atlases (Great Lakes		0.05
Lake Survey	0.05	
Surface Salinity Atlases		0.05
National Oceanographic Data Center	0.05	
Surface-Water Mass Transport Atlases		0.05
National Oceanographic Data Center	0.05	
Mean Sea Level Atlases		0.05
Coast and Geodetic Survey	0.05	
Bottom Temperature Atlases for Fishery Grounds		0.05
Bureau of Commercial Fisheries	0.05	
Ocean Engineering Reports		0.10
Naval Oceanographic Office	0.05	
Coastal Engineering Research Center	0.05	
Pollution Maps		0.05
Federal Water Pollution Control Administration	0.05	
Coastal and Marine Recreational Guides		0.05
Park Service (in cooperation with state and local agencies)		

TABLE VI-9 (CON'T)

INCREMENTS IN ANNUAL DATA MANAGEMENT COSTS
REQUIRED FOR "NEW" PRODUCTS AND DATA PARAMETER GROUPS

PRODUCT OR DATA PARAMETER GROUP	Annual Data Management Costs (Excluding Platform Costs) (millions of dollars)	
	Agency Cost	Total Cost
"New" Environmental Forecasting Products		
Sea Surface Water Level Forecasts		0.10
Weather Bureau	0.05	
Coast and Geodetic Survey	0.05	
Sea-Air Energy Exchange Prognoses		0.05
Weather Bureau (NMC)	0.05	
Inland Lakes Ice Forecasts		0.05
Weather Bureau	0.05	
New Data Parameter Groups		
Pressure, Temperature Depth		0.05
Great Lakes Regional Data Center (Water characteristics data base)	0.05	
Chemical (all chemical parameter groups except salinity and dissolved gases)		0.05
National Oceanographic Data Center (chemical data base)	0.05	
Rock or Sediment Description		0.05
National Oceanographic Data Center (sediment chemistry data base)	0.05	
Bottom Photographs		0.05
National Oceanographic Data Center (under-water photography data base)	0.05	
Geophysical Measurements		0.10
National Oceanographic Data Center (geothermal data base and seismic reflection profile data base)	0.10	
"Sea" Ice		0.05
Great Lakes Regional Data Center (ice observation data base)	0.05	
TOTAL MILLIONS		1.25

TABLE VI-10

REVISED PROJECTED DATA MANAGEMENT COSTS FOR PRODUCTS OR DATA PARAMETER GROUPS NEW TO A PARTICULAR AGENCY

	FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79	FY 80
BATHYMETRIC MAPS	0.45	0.45	0.45	0.55	0.55	0.55	0.55	0.55	[illegible]	0.65
SEA AND SWELL ATLASES	0.65	0.65	0.75	0.75	0.75	0.85	0.85	0.85	0.95	0.95
CLIMATOLOGICAL ATLASES	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
PRESSURE, TEMPERATURE, DENSITY	1.35	1.40	1.45	1.51	1.57	1.62	1.68	1.75	1.81	1.89
ROCK AND SEDIMENT DESCRIPTION	0.11	0.11	0.12	0.12	0.12	0.13	0.13	0.13	0.14	0.14

Determination of Unfulfilled Needs Score, Rate of Growth of Demand, and Rate of Change of Unfulfilled Needs for "New" Products and Data Parameter Groups

Other "new" products are characterized by approximately the same user-activities and unfulfilled needs as the existing priority products. The unfulfilled needs scores, rate of growth of demand and rate of change of unfulfilled needs for certain existing priority products can be assigned to the "new" products. Table VI-11 indicates the "new" products and their reference priority product.

The determination of the rate of growth of demand and the rate of change of unfulfilled needs for the "new" data parameter groups was accomplished in the same manner as that used for the existing data parameter groups since the parameters are not new. Only the use of the parameters by additional agencies is new.

Table VI-12 shows the projected data management costs for the "new" products and data parameter groups. Table VI-13 shows the projected unfulfilled needs for the "new" products and data parameter groups.

TABLE VI-11

"NEW" PRODUCTS AND REFERENCED PRIORITY PRODUCTS

NEW PRODUCT	REFERENCE PRIORITY PRODUCT
"NEW" ENVIRONMENTAL DESCRIPTIVE PRODUCTS	
COASTAL STATION ATLASES	OCEAN STATION ATLASES
GREAT LAKES STATION ATLASES	OCEAN STATION ATLASES
OCEAN ENGINEERING REPORTS	OCEAN ENGINEERING HANDBOOKS
POLLUTION MAPS	ESTUARINE FLUSHING PREDICTIONS
MEAN SEA LEVEL ATLASES	SEA AND SWELL ATLASES
BOTTOM TEMPERATURE ATLASES	FISHERY ADVISORIES
SURFACE SALINITY ATLASES	SEA SURFACE TEMPERATURE ATLASES
SURFACE-WATER MASS TRANSPORT ATLASES	SURFACE CURRENT ATLASES
SEA-AIR ENERGY EXCHANGE ATLASES	SEA SURFACE TEMPERATURE ATLASES
COASTAL AND MARINE RECREATIONAL GUIDES	SPORT FISHING ATLASES
"NEW" ENVIRONMENTAL FORECASTING PRODUCTS	
SEA SURFACE WATER LEVEL FORECASTS	COASTAL WEATHER AND WAVE FORECAST
SEA-AIR ENERGY EXCHANGE FORECASTS	SEA SURFACE TEMPERATURE CHART
INLAND LAKES ICE FORECASTS	INLAND LAKES ICE FORECASTS

TABLE VI-12

"NEW" PRODUCTS AND DATA PARAMETER GROUPS - PROJECTED DATA MANAGEMENT COSTS

	FISCAL YEAR									
	71	72	73	74	75	76	77	78	89	80
"NEW" ENVIRONMENTAL DESCRIPTIVE PRODUCTS (MILLIONS)										
COASTAL STATION ATLASES	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
GREAT LAKES STATION ATLASES	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
OCEAN ENGINEERING REPORTS	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.19	0.20
POLLUTION MAPS	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
MEAN SEA LEVEL ATLASES	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.08
BOTTOM TEMPERATURE ATLASES	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
SURFACE SALINITY ATLASES	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07
SURFACE-WATER MASS TRANSPORT ATLASES	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
SEA-AIR ENERGY EXCHANGE ATLASES	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.08
COASTAL AND MARINE RECREATIONAL GUIDES	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07
"NEW" ENVIRONMENTAL FORECASTING PRODUCTS (MILLIONS)										
SEA SURFACE WATER LEVEL FORECASTS	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.08
SEA-AIR ENERGY EXCHANGE FORECASTS	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
INLAND LAKES ICE FORECASTS	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.20	0.20	0.20
"NEW" DATA PARAMETER GROUPS (MILLIONS)										
GEOPHYSICAL MEASUREMENTS	0.10	0.11	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18
SEA ICE DATA	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.08
BOTTOM PHOTOS	0.05	0.06	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.09
CHEMICAL DATA	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06

TABLE VI-13

"NEW" PRODUCTS AND DATA PARAMETER GROUPS - PROJECTED UNFULFILLED NEEDS

	FISCAL YEAR									
	71	72	73	74	75	76	77	78	79	80
"NEW" ENVIRONMENTAL DESCRIPTIVE PRODUCTS (NORMALIZED SCORES)										
COASTAL STATION ATLASES	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
GREAT LAKES STATION ATLASES	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
OCEAN ENGINEERING REPORTS	0.30	0.32	0.33	0.35	0.36	0.38	0.40	0.42	0.44	0.46
POLLUTION MAPS	0.13	0.15	0.16	0.18	0.20	0.23	0.26	0.29	0.32	0.36
MEAN SEA LEVEL ATLASES	0.41	0.42	0.44	0.46	0.48	0.50	0.51	0.54	0.56	0.58
BOTTOM TEMPERATURE ATLASES	0.12	0.13	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20
SURFACE SALINITY ATLASES	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.28	0.29
SURFACE-WATER MASS TRANSPORT ATLASES	0.30	0.31	0.31	0.31	0.32	0.32	0.33	0.34	0.35	0.35
SEA-AIR ENERGY EXCHANGE ATLASES	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.28	0.29
COASTAL AND MARINE RECREATIONAL GUIDES	0.24	0.25	0.27	0.28	0.30	0.32	0.34	0.36	0.38	0.40
"NEW" ENVIRONMENTAL FORECASTING PRODUCTS (NORMALIZED SCORES)										
SEA SURFACE WATER LEVEL FORECASTS	0.52	0.57	0.63	0.69	0.76	0.84	0.92	1.02	1.12	1.23
SEA-AIR ENERGY EXCHANGE FORECASTS	0.64	0.67	0.71	0.74	0.78	0.82	0.86	0.90	0.95	0.99
INLAND LAKES ICE FORECASTS	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
"NEW" DATA PARAMETER GROUPS (NORMALIZED SCORES)										
GEOPHYSICAL MEASUREMENTS	0.51	0.56	0.63	0.70	0.77	0.86	0.96	1.06	1.17	1.29
SEA ICE DATA	0.73	0.73	0.74	0.75	0.76	0.76	0.77	0.78	0.78	0.79
BOTTOM PHOTOS	0.59	0.65	0.73	0.81	0.89	0.99	1.10	1.22	1.35	1.50
CHEMICAL DATA	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22

Determination of Total Annual Data Management Budget (F_t)

Solutions of the benefit/performance/cost model can be obtained for various assumed 10 year marine data management budgets.* Budget growth rates of low, moderate, and high were postulated. The average growth rate for the low budget is assumed to be 5%. The average growth rates for the moderate budget and high budget are assumed to be 10% and 15%, respectively. Model solutions were obtained for the 5 and 10 percent budget growth rates.

The growth rate for the early years is expected to be higher than the average 10-year rate due to the present backlog of unapplied technological capabilities. The growth rate is then expected to decrease as the present technology backlog is applied. Towards the end of the next decade, the growth rate is expected to increase because of the recognition of the difficulty in accommodating to the accelerated technological change and because of the increases in the volume of products and data to be produced over the decade. The NAVOCEANO shore-based system costs from the Technical Development Plan of Volume Two were used as a model for the shape of the total marine data management budget function. After smoothing the budget over the first several years, the shape of the NAVOCEANO curve matched the characteristics discussed above. The growth rate for each year was determined. Then the ratio of the growth rate for each year and the average growth rate was calculated. This ratio was then applied to the 5%, 10%, and 15% average growth rates to obtain growth rates for each year. The total yearly marine data management budget* functions F_t were then computed.

$$F_{rt} = F_{r(t-1)} \ (1 + Rr);$$

R = ratio of growth rate for each year and average growth rate for smoothed NAVOCEANO technical development plan budget requirements.

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*Priority data and product budget.

r = 5%, 10%, and 15%.

$F_{rt} = F_t$ assuming "r" average growth rate.

Table VI-14 lists the results of the calculation of the data management budget projections for a low average growth rate (5% average), a moderate average growth rate (10% average), and a high average growth rate (15% average).

Determination of the Minimum Performance Level (L_{it})

The minimum performance level (L_{it}) for product or data parameter i in year t is equal to the performance level of the previous year's solution.

$$L_{it} = P_{it-1}$$

$$P_{it} = 1.0 \text{ for FY 71}$$

Determination of the Maximum Performance Level (M_{it})

Maximum performance levels (M_{it}) are set 30% higher than the performance levels obtained from the previous year's solution. Thirty percent is considered to be the maximum reasonable annual growth rate in performances. Except in cases of rapid changes in Federal budget priorities (e.g., national emergency) performance growth rates greater than 30% would be difficult to achieve.

$$M_{it} = 1.30\ P_{it-1}$$

Correlation of Performance Level and Performance Factors

Table VI-15 indicates the relationship between performance levels and performance factors for certain products and agencies. These correlations are derived from the quantitative performance factors in the Technical Development Plan, Volume Two.

TABLE VI-14

FEDERAL MARINE DATA MANAGEMENT BUDGET* PROJECTIONS

Fiscal Year	Growth Rate (%)	Budget Assuming Low Growth Rate (Millions)	Growth Rate (%)	Budget Assuming Moderate Growth Rate (Millions)	Growth Rate (%)	Budget Assuming High Growth Rate (Millions)
1970	8-1/2	39.9	17	39.9	25-1/2	39.9
1971	6-1/2	43.3	13	46.6	19-1/2	50.0
1972	5	46.1	10	52.7	15	59.8
1973	4-1/2	48.4	9	58.0	13-1/2	68.7
1974	4	50.6	8	63.2	12	78.0
1975	3-1/2	52.6	7	68.2	10-1/2	87.4
1976	4	54.5	8	73.0	12	96.5
1977	4-1/2	56.6	9	78.9	13-1/2	108.1
1978	4-1/2	59.2	9	86.0	13-1/2	122.7
1979	5	61.9	10	93.8	15	139.1
1980		65.0		103.0		160.0
Average Growth Rate	5%		10%		15%	
Total 1971 to 1980		538.2		723.4		970.3

*Priority data and products.

TABLE VI-15

CORRELATION OF PERFORMANCE LEVELS AND PERFORMANCE FACTORS
LAKE SURVEY AND GREAT LAKES REGIONAL DATA CENTER

Performance Level	Performance Factor Recreational Craft* Chart Coverage
1.0	10%
2.0	20%
3.0	30%
4.0	40%
5.0	50%
6.0	60%
7.0	70%
8.0	80%
9.0	90%
10.0	100%

*From Technical Development Plan for the Lake Survey and the Great Lakes Regional Data Center (Volume Two).

TABLE VI-15 (CON'T)

CORRELATION OF PERFORMANCE LEVELS AND PERFORMANCE FACTORS

COASTAL ENGINEERING RESEARCH CENTER

Performance Level	Performance Factor Number of Wave Gauge Installations*
1.0	6
2.0	12
3.0	18
4.0	24
5.0	30
6.0	36
7.0	42
8.0	48
9.0	54
10.0	60
11.0	66
12.0	72
13.0	78
14.0	84
15.0	90
16.0	96
16.7	100

*From Coastal Engineering Research Center Technical Development Plan (Volume Two).

TABLE VI-15 (CON'T)

CORRELATION OF PERFORMANCE LEVELS AND PERFORMANCE FACTORS

NAVAL OCEANOGRAPHIC OFFICE* PERFORMANCE FACTORS

Performance Level	Time Between Updating Nautical Charts	Nautical Chart and Bathymetric Map Coverage	Time Delay For Input To Notice to Mariners
1.0	36 mos. (1.0)**	25% (1.0)	8 weeks (1.0)
2.0	18 mos. (2.0)	50% (2.0)	4 weeks (2.0)
3.0	12 mos. (3.0)	75% (3.0)	2.7 weeks (3.0)
3.6	9 mos. (4.0)	75% (3.0)	2 weeks (4.0)
4.4	7.2 mos. (5.0)	75% (3.0)	1.6 weeks (5.0)
5.0	6 mos. (6.0)	75% (3.0)	1.3 weeks (6.0)
5.3	6 mos. (6.0)	75% (3.0)	1.1 weeks (7.0)
5.7	6 mos. (6.0)	75% (3.0)	1 week (8.0)

*From Naval Oceanographic Office Technical Development Plan (Volume Two).

**The numbers in parenthesis are performance levels corresponding to individual performance factors (e.g., time between updating nautical charts). The performance level in the left-hand colume is the weighted average of these.

TABLE VI-15 (CON'T)

CORRELATION OF PERFORMANCE LEVELS AND PERFORMANCE FACTORS

PERFORMANCE FACTORS COAST AND GEODETIC SURVEY*

Performance Level	Increase Bathymetric Coverage of U.S. Continental Shelf (%)	Reduce Time Interval Between Updating Nautical Charts (Months)	Increase Small Craft Chart Coverage for the West Coast (%)	Reduce Time Interval Between Resurveys (Years	Increase Harbor Chart Coverage (%)
1.00	40 (1.0)**	24 (1.0)	25 1.0)	75 (1.0)	85 (1.0)
1.24	38 (1.25)	21 (1.25)	30 (1.25)	60 (1.25)	100 (1.18)
1.39	45 (1.5)	18 (1.5)	37-1/2 (1.5)	60 (1.25)	100 (1.18)
1.69	60 (2.0)	12 (2.0)	50 (2.0)	60 (1.25)	100 (1.18)
2.09	60 (2.0)	9 (3.0)	75 (3.0)	60 (1.25)	100 (1.18)
2.49	60 (2.0)	6 (4.0)	100 (4.0)	60 (1.25)	100 (1.18)

*From Coast and Geodetic Survey Technical Development Plan (Volume Two).

**Numbers in parenthesis are performance levels corresponding to an individual performance factor (e.g., bathymetric coverage of U.S. continental shelf). The performance level in the left-hand colume is the weighted average of these.

TABLE VI-15 (CON'T)

CORRELATION OF PERFORMANCE LEVELS AND PERFORMANCE FACTORS

WEATHER BUREAU PERFORMANCE FACTOR

Performance Level	Number of Weather Bureau Offices Making Marine Forecasts*
1.0	1
2.0	2
3.0	3
4.0	4
5.0	5
6.0	6
7.0	7
8.0	8
9.0	9
10.0	10
11.0	11
12.0	12
13.0	13
14.0	14

*From Weather Bureau Technical Development Plan (Volume Two).

TABLE VI-15 (CON'T)

CORRELATION OF PERFORMANCE LEVELS AND PERFORMANCE FACTORS

BUREAU OF COMMERCIAL FISHERIES

AND

BUREAU OF SPORT FISHERIES AND WILDLIFE

Performance Level	Performance Factor: Delay Time in Publishing Annual Fishery Statistics Report
1.0	2 years
2.0	1 year
3.0	8 months
4.0	6 months
5.0	5 months
6.0	4 months
7.0	3-1/2 months
8.0	3 months

The performance level solutions provided by the model are correlated with tables of performance level versus performance factors (such as Table VI-15) in order to determine the agency performance factors corresponding to a performance level solution. This information, plus budgets by product or data parameter and by agency, constitute the model solution.

MODEL SOLUTIONS

Model solutions are summarized in the series of tables that follow. The budget amounts shown in the tables are in all cases total annual amounts. Table VI-16 shows the performance level and budget allocation solutions for environmental description products for the years FY 71 and FY 80 and for the 5 and 10 per cent budget growth rate functions. Table VI-17 shows the same type of information for environmental forecasting products. The budget allocations by existing products and data and by new products and data are summarized in Table VI-18 for the 5 and 10 per cent solutions. The 10 per cent total budget growth rate plan provides for new data and product services, whereas the 5 per cent plan provides only for the improvement of existing products and services. The existing environmental description product budget for the 10 per cent plan is slightly less the budget for the 5 per cent plan in FY 71 due to the model allocating the additional funds provided by the 10 per cent plan primarily to new products and data. Performance level solutions provided by the model would be converted to performance factors by the method previously described. Table VI-19 shows the budget allocation by agency for each of 10 years for the 5 per cent plan. Table VI-20 shows the same information for the 10 per cent plan.

TABLE VI-16

MODEL SOLUTIONS - ENVIRONMENTAL DESCRIPTION PRODUCTS

Product	FY 71				FY 80			
	Performance Level		Budget (millions)		Performance Level		Budget (millions)	
	5%	10%	5%	10%	5%	10%	5%	10%
Bathymetric Map	1.30	1.30	$ .50	$ .59	1.69	2.86	$ 1.00	$ 1.86
Ocean Station Atlas	1.30	1.30	.60	.50	1.30	1.69	.80	1.00
Nautical Chart	1.00	1.00	13.40	13.40	1.00	1.00	19.00	19.00
Climatological Atlas	2.00	2.00		.10		21.2		1.06
Sea and Swell Atlas	1.30	1.30	.80	.84	1.30	1.69	1.20	1.61
Surface Current Atlas	1.30	1.30	.30	.30	1.69	2.86	.50	.90
Geological and Geophysical Report and Map	1.30	1.00	1.70	1.30	1.30	1.00	3.10	2.40
Fishery Resource Atlas	1.30	1.30	.40	.40	1.30	1.69	.50	.70
Sportfishing Atlas	1.30	1.30	.50	.50	1.30	1.69	.80	1.00
Magnetic Field Map	1.30	1.00	1.00	.80	1.30	1.00	2.10	1.60
Gravity Field Map	1.30	1.00	1.40	1.10	1.30	1.00	2.90	2.20
Sea Surface Temperature Atlas	1.30	1.30	.10	.10	1.69	3.71	.30	.40
Ice Atlas	1.30	1.30	.10	.10	1.69	2.85	.30	.60
Fishery Statistics Report	1.18	1.00	.60	.50	1.18	1.00	.80	.70
Navigation Notice	1.00	1.00	.70	.90	1.00	1.00	1.10	1.10
TOTALS			$22.30	$21.53			$34.4	$36.13

TABLE VI-17

MODEL SOLUTIONS - ENVIRONMENTAL FORECASTING PRODUCTS

Product	FY 71				FY 80			
	Performance Level		Budget (millions)		Performance Level		Budget (millions)	
	5%	10%	5%	10%	5%	10%	5%	10%
Sea Surface Temperature Chart	1.30	1.30	$ .40	$ .40	1.69	4.83	$ .60	$1.86
Thermal Structure Forecast	1.30	1.30	2.30	2.30	1.30	1.30	2.80	2.70
Extended Range Weather Forecast	1.30	1.30	.10	.10	6.27	8.83	.60	.80
Coastal Weather and Wave Forecast	1.30	1.30	1.80	1.90	1.69	1.30	3.90	3.00
Wave Height Forecast	1.30	1.30	.90	.90	1.30	2.71	1.30	2.70
Hemispheric Weather Chart	1.00	1.30	1.30	1.70	1.00	1.53	1.70	2.60
Products Obtained from Satellite Remote Sensors	1.00	1.00	7.10	7.10	1.00	1.00	8.40	8.40
High Seas Weather Forecast	1.30	1.30	1.10	.90	2.41	1.69	2.40	1.70
Fishery Products Report	1.30	1.30	.10	.10	6.06	10.60	.60	1.10
Surf Forecast	1.30	1.30	.10	.10	3.71	6.27	.80	1.20
Oceanic Ice Forecast	1.30	1.30	.10	.10	2.86	4.83	.30	.50
Tsunami Warning	1.30	1.30	.50	.50	1.69	1.69	1.00	1.00
Tropical Cyclone Advisory	1.30	1.30	.70	.70	1.69	1.69	1.40	1.40
Storm Surge Advisory	1.30	1.30	.10	.10	6.27	10.60	.60	1.10
Estuarine Flushing Prediction	2.00	2.00	.20	.20	2.60	4.98	.30	.50
Fishery Advisory	2.00	2.00	.20	.20	2.60	4.39	.30	.40
TOTALS			$17.00	$17.30			$27.00	$31.00

TABLE VI-18

SUMMARY OF MODEL SOLUTIONS -
BUDGET ALLOCATIONS FOR 5% AND 10% AVERAGE BUDGET GROWTH RATES

	FY 71 BUDGET (millions)		FY 80 BUDGET (millions)	
	5%	10%	5%	10%
EXISTING ENVIRONMENTAL DESCRIPTION PRODUCTS	\$ 22.30	\$ 21.53	\$ 34.40	\$ 36.13
EXISTING ENVIRONMENTAL FORECASTING PRODUCTS	17.00	17.30	27.00	31 00
EXISTING DATA	5.3	5.53	10.13	15.38
NEW ENVIRONMENTAL DESCRIPTION PRODUCTS		1.12		9.39
NEW ENVIRONMENTAL FORECASTING PRODUCTS		.46		4.99
NEW DATA		.52		7.70
TOTALS	\$44.65	\$46.46	\$71.53	\$104.59

TABLE VI-19

MODEL SOLUTIONS OF PRIORITY DATA AND PRODUCT BY AGENCY IN MILLIONS OF DOLLARS - 5% AVERAGE TOTAL BUDGET GROWTH RATE

AGENCY	FY 70	FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79	FY 80
Naval Oceanographic Office	13.0	13.9	15.0	15.6	16.4	17.0	17.8	18.6	19.4	20.7	21.9
Naval Weather Service	3.53	4.42	4.91	5.80	6.05	6.10	6.16	7.24	7.39	7.39	7.93
National Environmental Satellite Center	7.1	7.1	7.1	7.4	7.5	7.7	7.8	8.0	8.1	8.3	8.4
Coast Guard	2.30	2.78	2.98	3.15	3.34	3.55	3.55	3.68	3.68	3.68	3.81
Coast and Geodetic Survey	4.9	5.2	5.8	6.0	6.3	6.5	6.7	6.9	7.4	7.6	8.0
National Oceanographic Data Center	2.50	3.24	3.46	3.80	3.97	4.12	4.34	4.56	4.78	5.15	5.54
Weather Bureau	1.48	1.74	2.30	2.66	2.96	3.21	3.21	4.02	4.17	4.37	4.63
Bureau of Commercial Fisheries	1.2	1.5	1.8	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.6
Environmental Data Service	1.17	1.51	1.83	2.06	2.26	2.34	2.48	2.61	2.80	2.94	3.00
U.S. Geological Survey	0.8	1.0	1.1	1.2	1.3	1.4	1.4	1.5	1.7	1.8	1.9
U.S. Lake Survey (Incl. GLRDC)	0.80	0.85	0.94	1.04	1.06	1.07	1.08	1.20	1.22	1.23	1.34
Bureau of Sport-fisheries and Wildlife	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.8
Smithsonian Oceano-graphic Sorting Center	0.40	0.51	0.63	0.64	0.69	0.71	0.76	0.80	0.95	1.08	1.18
Coastal Engineering Research Center	0.3	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.6
TOTALS	39.44	44.65	58.85	52.05	54.73	56.80	58.53	62.51	65.09	67.84	71.53

TABLE VI-20

MODEL SOLUTIONS OF PRIORITY DATA AND PRODUCT BY AGENCY IN MILLIONS OF DOLLARS - 10% AVERAGE TOTAL BUDGET GROWTH RATE

AGENCY	FY 70	FY 71	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78	FY 79	FY 80
Naval Oceanographic Office	13.00	13.61	14.75	15.82	17.21	17.90	19.03	19.86	20.49	21.84	22.87
Naval Weather Service	3.53	4.56	5.53	6.30	6.42	6.64	6.79	7.54	7.94	8.24	9.02
National Environmental Satellite Center	7.1	7.1	7.2	7.4	7.5	7.7	7.8	8.0	8.1	8.3	8.4
Coast Guard	2.30	2.82	3.15	3.47	3.67	3.90	4.10	4.95	5.05	5.15	5.33
Coast and Geodetic Survey	4.90	5.40	5.99	6.47	7.34	7.67	8.25	9.14	10.21	11.26	12.97
National Oceanographic Data Center	2.50	3.94	5.28	5.90	6.71	7.56	8.66	10.12	11.12	13.04	14.99
Weather Bureau (Incl. NMS)	1.48	2.30	2.87	3.19	3.55	4.15	4.77	5.99	6.82	7.71	9.08
Bureau of Commercial Fisheries	1.20	1.50	1.80	2.00	2.30	2.50	2.60	3.10	3.20	3.40	4.20
Environmental Data Service (NWRC)	1.17	1.46	1.81	2.24	2.77	3.57	4.01	4.62	4.93	5.60	6.09
U.S. Geological Survey	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.2	1.3	1.4	1.5
U.S. Lake Survey (Incl. GLRDC)	0.80	1.25	1.46	1.71	2.04	2.20	2.50	3.00	3.40	3.91	4.83
Bureau of Sport-fisheries and Wildlife	0.4	0.5	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	1.0
Smithsonian Oceanographic Sorting Center	0.40	0.51	0.71	0.81	1.00	1.12	1.21	1.24	1.40	1.55	1.67
Coastal Engineering Research Center	0.30	0.51	0.66	0.72	0.81	0.90	1.02	1.06	1.19	1.24	1.27
U.S. Park Service	0.00	0.10	0.13	0.17	0.26	0.34	0.45	0.58	0.68	0.84	0.84
FWPCA	0.00	0.10	0.13	0.17	0.22	0.29	0.41	0.53	0.53	0.53	0.53
TOTALS	39.88	46.46	53.07	57.97	63.50	68.24	73.51	81.73	87.16	94.81	105.59

The major purpose of the model is to provide for the allocation of funds and performance levels to priority product and data service improvements and developments in a given year for any assumed total budget function. However, given the uncertainty of the availability of future marine data management funds, it is appropriate to evaluate several plans in order to determine which of the plans in most cost effective. The 5 per cent solution (Plan A) and 10 per cent solution (Plan B) are compared in the next section. Plan C is described in considerable detail in Volume Two. Plan C contains provisions for the development of major data acquisition networks in addition to provisions for the improvement of existing products and services and the introduction of new products and services. Plan C was not developed with the aid of the model. Its development was based on a detailed consideration of a variety of needs in the agencies and in the marine data network for upgrading products and services. Detailed hardware, software development and personnel requirements are specified for each agency and program area (e.g. marine forecasting, research and support) for the next 10 years. The superiority of Plan B over Plan A is demonstrated in the next section. Plan C can be viewed as another plan in a continuum of plans that provide progressively greater marine data management capability at progressively higher costs.

EVALUATION OF SOLUTIONS

It is also of interest to select the best plan, once two or more plans have been developed with the aid of the model. In the section which follows, an evaluation is made of Plan A and Plan B.

B_{ai} = benefits provided by Plan A in year i in units.

B_{bi} = benefits provided by Plan B in year i in units.

C_{ai} = total cost of implementing Plan A in year i in millions of dollars.

C_{bi} = total cost of implementing Plan B in year i in millions of dollars.

ΔB_i = difference in benefits between Plan B and Plan A for year i.

ΔC_i = difference in costs between Plan B and Plan A for year i.

The benefits and costs of implementation for Plan A and Plan B are tabulated in Table VI-21 and plotted in Figure VI-7. It can be seen from the plots that the additional benefits provided by Plan B increase at a higher rate with time than does the increase in cost over Plan A. However, it cannot be concluded on this evidence alone that Plan B is superior to Plan A. Benefits and costs are not in commensurate units, i.e., dollars. Therefore, it cannot be determined from this analysis alone whether an increase in benefits of Plan B over Plan A is greater, in dollar terms, than the increase in cost of Plan B over Plan A. The analysis which follows provides the basis for ranking the two plans.

The criterion for the selection of Plan B over Plan A is that the summation over ten years of the additional benefits provided by Plan B be equal to or greater than the summation of the additional costs. This criterion can be formulated as follows.

TABLE VI-21

COMPARISON OF BENEFITS AND COSTS
OF PLAN A AND PLAN B

	PLAN A			PLAN B		
FY	Benefits (Units) Ba	Total Costs (Millions) Ca	Ba/Ca	Benefits (Units) Bb	Total Costs (Millions) Cb	Bb/Cb
71	23.67	$ 44.54	.530	36.29	$ 46.46	.781
72	29.76	48.85	.609	48.23	53.07	.909
73	34.71	52.05	.667	61.75	57.97	1.065
74	40.58	54.73	.741	79.30	63.50	1.249
75	45.33	56.80	.798	98.79	68.24	1.448
76	51.69	58.58	.882	129.71	73.51	1.765
77	58.76	62.51	.940	159.76	81.73	1.955
78	71.50	65.09	1.098	194.53	87.16	2.232
78	86.30	67.84	1.272	247.75	94.81	2.613
80	110.09	71.53	1.539	315.63	104.59	3.018

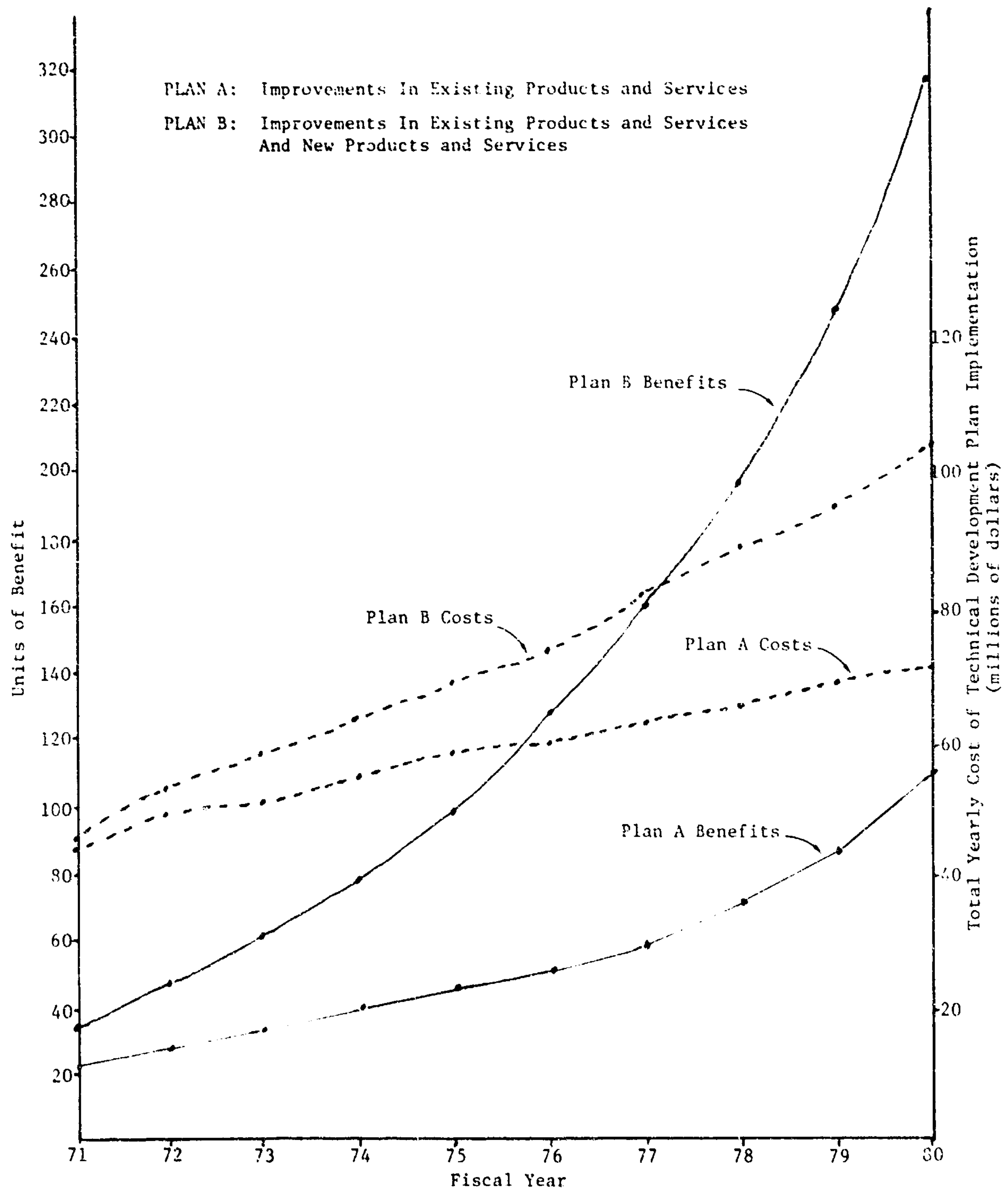


FIGURE VI-7. COMPARISON OF BENEFITS AND COSTS - TECHNICAL DEVELOPMENT PLANS A AND B

ΔB_i = difference in benefits between Plan B and Plan A for year i. (3)

ΔC_i = difference in costs between Plan B and Plan A for year i. (4)

$$\sum_i K_i \Delta B_i \geq \sum_i \Delta C_i \quad i = 1 \text{ to } 10. \tag{5}$$

$$= \sum_i K_i (B_{bi} - B_{ai}) \geq \sum_i (C_{bi} - C_{ai}) \tag{6}$$

K_i is a conversion factor which is equal to the economic benefit in dollars per unit of benefit used in the model. This factor is required because the benefits used in the model are dimensionless numbers, whereas costs are in dollars. A comparison of an increment in benefits with an increment in costs is valid only when the two quantities are in commensurate units. If ΔB_i is greater than ΔC_i for all 10 years, the criterion for selecting Plan B over Plan A is obviously satisfied. For this condition to be satisfied,

$$K_i (B_{bi} - B_{ai}) > \left(C_{bi} - C_{ai}\right) \text{ for all i.} \tag{7}$$

$$K_i \frac{B_{ai}}{C_{ai}} \left(\frac{B_{bi}}{B_{ai}} - 1\right) > \left(\frac{C_{bi}}{C_{ai}} - 1\right) \tag{8}$$

$$K_i \frac{B_{ai}}{C_{ai}} > \frac{\left(\frac{C_{bi}}{C_{ai}} - 1\right)}{\left(\frac{B_{bi}}{B_{ai}} - 1\right)} \tag{9}$$

$$K_i > \frac{C_{bi} - C_{ai}}{B_{bi} - B_{ai}} \tag{10}$$

If (10) is satisfied, then Plan B is superior to Plan A. If K_i is set equal to $\frac{C_{ai}}{B_{ai}}$, the condition for satisfying (10) is

$$1 > \frac{\left(\frac{C_{bi}}{C_{ai}} - 1\right)}{\left(\frac{B_{bi}}{B_{ai}} - 1\right)} \tag{11}$$

$$\frac{B_{bi}}{B_{ai}} > \frac{C_{bi}}{C_{ai}} \tag{12}$$

$$\frac{B_{bi}}{C_{bi}} > \frac{B_{ai}}{C_{ai}} \tag{13}$$

The benefit/cost ratio of Plan B must be greater than the benefit/cost ratio of Plan A in each year. It is valid to set $K_i = \frac{C_{ai}}{B_{ai}}$ if

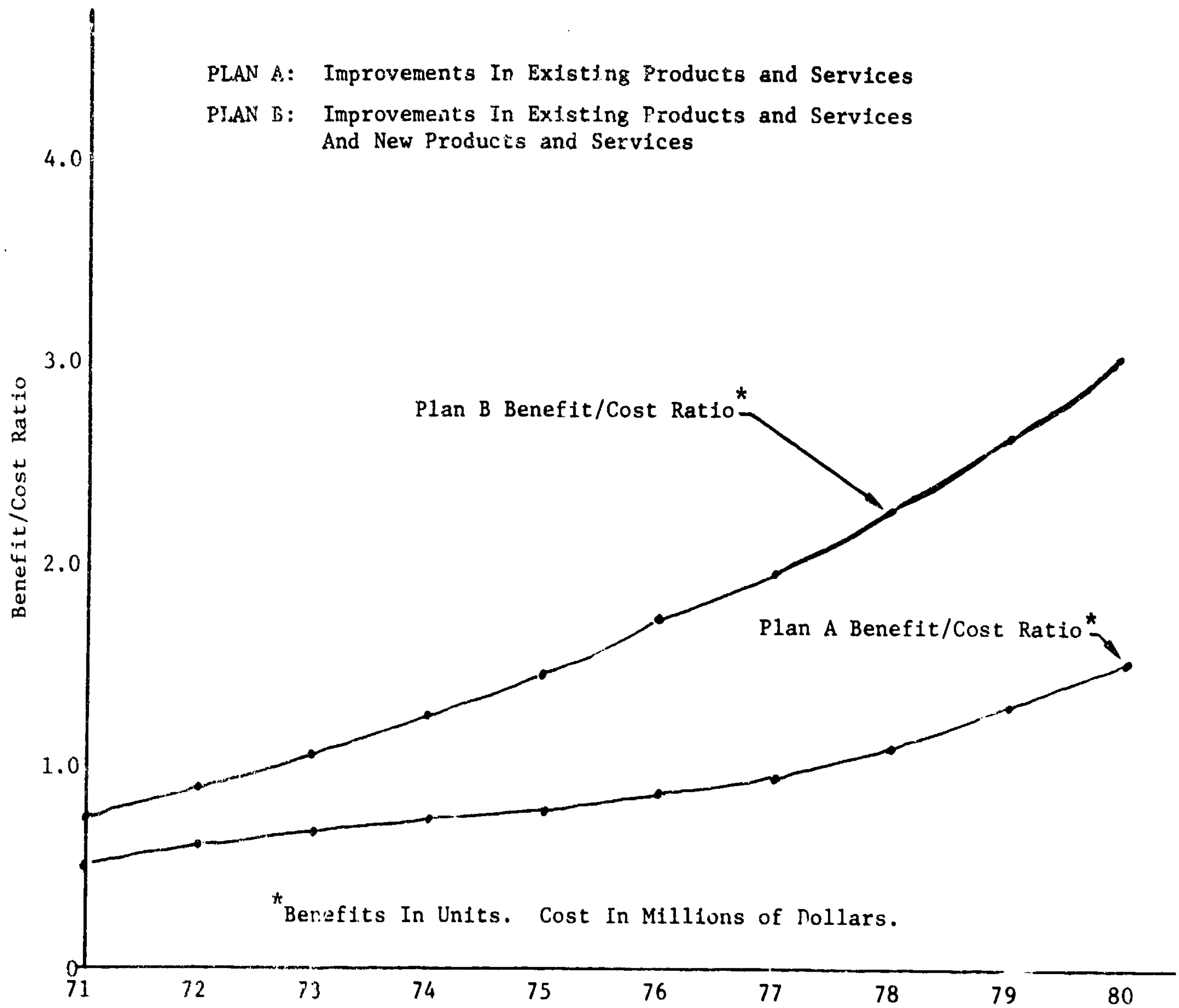
$$\frac{C_{ai}}{B_{ai}} > \frac{C_{bi} - C_{ai}}{B_{bi} - B_{ai}} \quad \text{for each year } i. \tag{14}$$

Then it is assured that (10) is satisfied. In order to determine whether this condition was satisfied, the calculations shown in Table VI-22 were made. In each year (14) is satisfied. Therefore, (13) can be used to determine whether Plan B is better than Plan A. The calculations for this test are shown in Table VI-21 and are plotted in Figure VI-8. In every year the benefit/cost ratio of Plan B is greater than the benefit/cost ratio of Plan A. Therefore, Plan B would be used in preference to Plan A, if the required additional funds were available. The results of this analysis also means that a Technical Development Plan which provides for the development of new products and services is superior to one which is limited to the improvement of existing products and services.

TABLE VI-22

COST/BENEFIT EVALUATION TABLE
PLAN A AND PLAN B

	Benefits (Units)			Total Costs (Millions)				
FY	Plan A Ba	Plan B Bb	Bb-Ba	Plan A Ca	Plan B Cb	Cb-Ca	$\frac{Ca}{Ba}$	$\frac{Cb-Ca}{Bb-Ba}$
71	23.67	36.29	12.62	$44.65	$46.46	$ 1.81	1.887	.143
72	29.76	48.23	18.47	48.85	53.07	4.22	1.642	.228
73	34.71	61.75	27.04	52.05	59.97	7.92	1.499	.293
74	40.58	79.30	38.72	54.73	63.50	8.77	1.350	.226
75	45.33	98.79	53.46	56.80	68.24	11.44	1.253	.214
76	51.67	129.71	78.04	58.58	73.51	14.93	1.134	.191
77	58.76	159.76	101.00	62.51	81.73	19.22	1.064	.190
78	71.50	194.53	123.03	65.09	87.16	22.07	.911	.179
79	86.30	247.75	161.45	67.84	94.81	26.97	.786	.167
80	110.09	315.63	205.54	71.53	104.59	33.06	.650	.161



NOTE: A benefit/cost ratio >1 does not necessarily mean that benefits exceed costs for a given plan. The benefit/cost ratios are only used to compare one plan with another, i.e., if the ratios of Plan B exceed those of Plan A, then Plan B is superior to Plan A.

FIGURE VI-8. BENEFIT/COST RATIOS OF PLAN A AND PLAN B

VII. SUMMARY OF TECHNICAL DEVELOPMENT PLAN

OBJECTIVES, SCOPE, AND METHODOLOGY

This section contains a summary of the Technical Development Plan (TDP), including Objectives, Scope, and Methodology; Agency Development Plans; and Marine Data Network Development Plans. The details of the TDP appear in Volume Two, Technical Development Plan.

OBJECTIVES

The objective of the Technical Development Plan (TDP) is to improve marine data products and services provided by the Federal Government to a variety of users. Users of marine data products and services are found in the fields of research; transportation; naval planning and operations; marine mapping and charting; marine forecasting; commercial and sportfishing; Federal, State, and regional planning and management; and public marine recreational and educational activities. The needs, including the priority needs, of data users are described in Volume One of this report.

The TDP recommends that products and services be improved both by enhancing existing products and services and by introducing new products and services. In order to support these improvements, recommendations are also made for increases in data acquisition, improvements in existing data bases and the development of new data bases. The mechanisms chosen for achieving greater benefits for users are (1) the upgrading of Federal agency data service and product operations and (2) the improvement of the marine data network for the collection, transmission, storage and dissemination of marine data. In order to achieve the objective of the TDP, a 10-year, time-phased plan has been designed which provides the resources necessary to achieve the improvements in Federal products and services desired by users. The TDP includes provisions for new instrumentation and new data communication and processing

hardware, hardware costs, software development and maintenance, software personnel and costs, computer operations personnel and costs, and application and discipline personnel and costs which are required in the next decade to achieve improvements in products and services and to develop new products and services.

In this study, three TDP alternatives have been considered. Each alternative corresponds to different assumed levels of total annual funds available for marine priority data and products in the next decade. The first alternative (Plan A) is based on a budget appropriate for the improvement of existing products and services but with no provisions for new products and services. The second plan (Plan B) provides for improvements in existing products and services and the development and implementation of new products and services. The highest-budget plan (Plan C) contains the same elements as the middle budget plan but also provides for the implementation of major data acquisition networks, e.g., coastal wave gauge network. Three plans have been formulated, rather than one, as a contingency against the uncertainties of future marine budgets.

SDC has developed a cost performance model which has been implemented on the SDC IBM 360/67. This model can be used to generate TDP plans for any assumed total priority data and product budget for any number of years desired. The model outputs are (1) budget allocations by product and data type and (2) product and data service performance levels (these are defined in Chapter VI, Volume One). Total product and data service budgets can be distributed to individual agency budgets by the method described in Chapter VI, Volume One. The model can be implemented on any computer which is supplied with a mathematical programming package. The model does not provide the level of detail of hardware requirements, software costs, etc., shown in this TDP. However, the budget allocations of the model can be used as a basis for determining the detailed requirements.

The three plans are discussed and evaluated in Chapter VI, Volume One. This volume describes Plan C in detail and is the plan recommended for implementation, assuming the availability of required funds.

SCOPE

The TDP includes both individual agency and marine data network development plans. The two plans constitute the National Data Program for the Marine Environment. The TDP is addressed to the requirements for improving individual agency data service operations and the broader requirement of strengthening the entire marine data network.

The Federal agencies which are included in the TDP are:

- Lake Survey (LS) and Great Lakes Data Center (GLDC)
- Coastal Engineering Research Center (CERC)
- Naval Oceanographic Office (NAVOCEANO)
- Coast and Geodetic Survey (C&GS)
- U.S. Geological Survey (USGS)
- Weather Bureau Offices (WB)
- National Meteorological Center (NMC)
- National Environmental Satellite Center (NESC)
- Fleet Numerical Weather Central (FNWC)
- Bureau of Commercial Fisheries (BCF)
- Bureau of Sport Fisheries and Wildlife (BSF&W)
- Federal Water Pollution and Control Administration (FWPCA)
- U.S. Coast Guard (USCG)
- National Oceanographic Data Center (NODC)
- National Weather Records Center (NWRC)
- Smithsonian Oceanographic Sorting Center (SOSC)

This group of agencies does not include all Federal organizations having responsibilities for marine data management. It does include those having

a significant influence on the collection, storage, processing and dissemination of marine data and the production and dissemination of data products.

In order to ensure the implementation of the National Data Program, responsibilities for its implementation must reside with individual agencies until a national marine and atmosphere agency is established. Therefore, considerable emphasis is accorded to recommendations which require individual agency action. In addition, many of the recommendations require interagency cooperation--for example, collection of environmental data in the coastal zone and the publication of a coastal atlas, production of wave and ice charts for the Great Lakes, establishment of regional data service offices, operation of a national coastal wave gauge network, development of national marine data directories and indices, and the operation of a national fishery statistics network. Wherever interagency effort is required, a lead agency is recommended in order to fix responsibilities for program implementation. Interagency efforts would be coordinated by the staff of the Marine Sciences Council and the Data Management Advisory Panel until a national oceanographic and atmospheric agency is created.

Although marine activities are funded primarily on an agency basis, planning and budgeting is also done on a program basis. Hence, the TDP identifies the requirements for implementing data programs for Great Lakes and coastal development; mapping, charting and marine environment description; marine forecasting, research and support; fisheries; water quality; onshore buoy data management; and national data centers.

In addition to the requirement for interagency cooperation in implementing the TDP, there is also the need for cooperation among the Federal agencies, States, universities and industry for the exchange of data and the efficient routing of data from collector to user. Examples of situations in which a cooperative effort at various levels is required are the participation of the States and regions with the Federal Government in the preparation of coastal atlases and the transfer of data between industry and other elements of the marine community.

Only priority products and data are considered in the TDP. Because of this, one should not expect to find an equivalence between resource requirements presented in the TDP and the utilization of resources in present agency operations. Also, some agencies which have historically operated on a small budget have been recommended for substantial upgrading. Other agencies, with larger budgets, may not receive a corresponding degree of attention because of an absence of major data management problems. There must exist important user needs and present inadequacies in data services in order for a recommendation to be included in the TDP. In general, a strong positive correlation will be found between problems which exist in data management and the resources recommended for agency operations. The main criteria for TDP recommendations are the user benefits which will result from product and service improvements. The size of present agency data operations or contributions to marine science programs have not been used as criteria for recommending improvements or increases in resources.

There is considerable emphasis in the TDP on the improvement of products and services for public and private users--merchant mariners, fishermen, small craft operators, swimmers, and residents of the coastal zone. These user groups are large, poorly organized, and ill-equipped to make their needs known to the Federal Government. In accordance with the emphasis on the needs of these users, such products as coastal weather and wave forecasts, nautical charts, small craft charts, and fishery statistics receive considerable attention in the TDP.

METHODOLOGY

The methodology for the design of the TDP consists of the following steps:

1. Based on the determination of user needs and the priority of needs, requirements for improvements in existing products and services and new products and services are established, e.g., the priority need to reduce the time interval between updating nautical charts and the need to provide coastal atlases.

2. Improvements in product or service performance are programmed to be consistent with the feasibility of providing the resources which are required to implement the improvements within the decade. In addition, maximum performance levels are established to be consistent with user needs within the decade. For example, a reduction in the time delay of incorporating changes in Notice to Mariners from eight weeks to one week over a period of 10 years is recommended; reduction in the delay to less than one week would be of no practical value. Gradual improvements over the decade which are consistent with the rate at which resources can be provided have been recommended. The model mentioned previously is used as an aid in allocating funds to product and data parameter groups and for determining appropriate rates of product and data service improvement.

3. Any new data collection or data base developments that are required in order to implement product and service improvements are specified. It is axiomatic for good systems work to start with the identification and analysis of the requirements for outputs--products and services in terms of their quality, quantity, frequency of output and timeliness--and then to establish the requirements for data needed to furnish the required outputs. In some cases (data centers) the output is primarily data, or summaries of data, rather than a standard product, such as a nautical chart. However, the principle of specifying user requirements before specifying data inputs or bases still applies. This is in contradistinction to the approach of specifying the data collection and data base requirements first and outputs last. In the former approach, the outputs govern the inputs and no greater input is required than needed to supply the outputs. In the latter approach, more input may be generated than is required to satisfy output requirements.

4. Computer hardware and data communication equipment requirements and costs are specified for achieving the needed improvements.

5. Software development and maintenance requirements and costs for the improvement and creation of products, data bases, and data acquisition are specified.

6. Computer operations personnel required to staff new or augmented computer facilities are determined.

7. Applications personnel, e.g., cartographers and discipline personnel, are specified.

The TDP contains both new requirements and costs and extrapolations of existing requirements and costs. In general, all hardware, software, and computer operations requirements and costs represent new requirements. Discipline or applications personnel requirements are usually forecasts of future requirements for existing organization components. Total annual costs for each agency for each of ten years, and a ten-year total cost for agency operations, have been determined. These are the amounts which would be required each year and for the decade to implement the TDP and consist of both new costs and extensions of presently incurred costs.

As a general strategy, the addition of resources is programmed to occur most rapidly in the early years of the TDP in an attempt to bring the management of marine data in line with available technology. Usually, the increments in funding proceed at a more modest rate in the later years of the decade as unit costs are lowered through the application of technology and as increased sophistication in data management prevails.

AGENCY AND PROGRAM DEVELOPMENT PLANS

The Technical Development Plan (TDP) is summarized by agency and program according to the following program categories:

- Great Lakes and Coastal Development
- Mapping, Charting and Marine Environment Description
- Marine Forecasting, Research and Support
- Fisheries
- Water Quality
- Onshore Buoy Data Management
- National Data Centers

The TDP is also summarized by the major categories of data management activity. These are:

- Product/Service Requirements
- Data Base Development Requirements
- New Data Acquisition/Communication System Requirements

The product, data base development and new data acquisition and communication system requirements for the time period FY 71-80 are summarized by program (e.g., Great Lakes and Coastal Development) and agency in Table VII-1. In general, data acquisition activities are required for all data base development requirements shown in the table. The column labeled "New Data Acquisition and Communication System Requirements" requires significantly new systems of data acquisition and/or communication, such as a national network of coastal wave gauge installations and associated telemetry equipment. Products, services, and data bases in Table VII-1 have been classified according to requirements for improvements in existing products, services, and data bases (1), and requirements for new products, services and data bases (2). The

TABLE VII-1

TECHNICAL DEVELOPMENT PLAN (PLAN C) SUMMARY OF PRIORITY PRODUCT/SERVICE, DATA BASE AND DATA ACQUISITION REQUIREMENTS, FY 70-81

AGENCY	PRODUCT/SERVICE REQUIREMENTS	DATA BASE DEVELOPMENT REQUIREMENTS	NEW DATA ACQUISITION/ COMMUNICATION SYSTEM REQUIREMENTS
GREAT LAKES AND COASTAL DEVELOPMENT PROGRAM			
LAKE SURVEY AND GREAT LAKES DATA CENTER	• ICE ATLAS AND CHART (1) • RECREATION CHART (1) • WAVE CHART AND ATLAS (1) • SURFACE CURRENTS CHART (1) • BATHYMETRIC MAP (1) • PRODUCTS AND SERVICES CATALOG (2) • GREAT LAKES CLIMATOLOGICAL ATLAS (2) • ON-LINE ENGINEERING COMPUTATION (2)	• DATA INVENTORY (1) • WATER QUANTITY (1) • WATER MOTION (1) • POLLUTION (2) • ICE AND SNOW (2) • WAVE (2) • SURFACE CURRENTS (2) • RIVER FLOW (2) • BATHYMETRIC (2)	• SHIPBOARD DIGITAL HYDROGRAPHIC AND BATHYMETRIC DATA COLLECTION
COASTAL ENGINEERING RESEARCH CENTER	• COASTAL WAVE ANALYSIS (1) • LITTORAL PROCESSES ANALYSIS (1) • SEDIMENT ANALYSIS (1) • LABORATORY ANALYSIS (1) • COASTAL ENGINEERING REPORT (2)	• COASTAL WAVE (1) • LABORATORY DATA (1)	• COASTAL WAVE DATA NETWORK
MAPPING, CHARTING AND MARINE ENVIRONMENT DESCRIPTION PROGRAM			
NAVAL OCEANOGRAPHIC OFFICE	• BATHYMETRIC MAP (1) • NAUTICAL CHART (1) • NOTICE TO MARINERS (1) • SEA SURFACE TEMPERATURE ATLAS (1) • ICE ATLAS (1) • OCEAN STATION ATLAS (1) • PILOT CHART (1) • SOUND VELOCITY ATLAS (1) • THERMOCLINE DEPTH CHART (1) • MAGNETIC FIELD MAP (1) • GRAVITY FIELD MAP (1) • SURFACE CURRENT CHART (1) • SEA & SWELL CHART (1) • MARINE GEOLOGY ATLAS (1) • SUBSURFACE CURRENT CHART & ATLAS (2) • OCEAN ENGINEERING HANDBOOK (2)	• BATHYMETRIC (1) • TOPOGRAPHIC (1) • NAVIGATION AIDS/ HAZARDS (1) • HYDROGRAPHIC (1) • MAGNETIC (1) • GRAVITY (1) • ICE OBSERVATIONS (1) • SST OBSERVATIONS (1) • SUB & SURFACE CURRENTS (1) • SURFACE METEOROLOGICAL OBSERVATIONS (NWRC) (1) • OCEAN STATION (NODC) (1) • BT (NODC) (1) • OCEAN ENGINEERING (2)	• SHIPBOARD DIGITAL HYDROGRAPHIC, BATHYMETRIC, GEOPHYSICAL AND OCEANOGRAPHIC DATA COLLECTION

(1) Improvement of existing priority product, service or data base is required.
(2) New product, service or data base is required.

TABLE VII-1 (Cont'd.)
TECHNICAL DEVELOPMENT PLAN (PLAN C) SUMMARY OF PRIORITY PRODUCT/SERVICE, DATA BASE AND DATA ACQUISITION REQUIREMENTS, FY 70-81

AGENCY	PRODUCT/SERVICE REQUIREMENTS	DATA BASE DEVELOPMENT REQUIREMENTS	NEW DATA ACQUISITION/ COMMUNICATION SYSTEM REQUIREMENTS
COAST AND GEODETIC SURVEY	• BATHYMETRIC MAPS (1) • NAUTICAL CHART (1) • SMALL CRAFT CHART (1) • TSUNAMI WARNINGS (1) • TIDE TABLES (1) • TIDAL CURRENT TABLES AND CHARTS (1) • COASTAL ATLAS (2) • SEA LEVEL VARIATION CHART AND TABLE (2)	• BATHYMETRIC (1) • TOPOGRAPHIC (1) • HYDROGRAPHIC (1) • NAVIGATIONAL AIDS/ HAZARDS (1) • MAGNETIC (1) • GRAVITY (1) • TIDES (1)	• BATHYMETRIC SURVEY OF CONTINENTAL SHELF. • HYDROGRAPHIC RESURVEYS. • SHIPBOARD DIGITAL HYDROGRAPHIC, BATHYMETRIC, GEOPHYSICAL AND OCEANOGRAPHIC DATA COLLECTION. • COASTAL ATLAS DATA COLLECTION.
U.S. GEOLOGICAL SURVEY	• DIRECTORY OF MARINE GEOLOGICAL PRODUCTS (2) • SHIP TRACK MAPS (2) • PROFESSIONAL PAPER BIBLIOGRAPHY (2) • BOTTOM CHARACTERISTICS OCEAN ENGINEERING REPORTS (2) • CLEARINGHOUSE FOR THE EXCHANGE OF INDUSTRY DATA (2)	• CONSOLIDATED GEOLOGICAL PRODUCT DESCRIPTOR, PRODUCT DIRECTORY, PROFESSIONAL PAPER AND SHIP TRACK INDEX (2) • INDUSTRY DATA AVAILABILITY/NEEDS FILE (2) • INDUSTRY SUPPLIED DATA FILE (2)	
MARINE FORECASTING, RESEARCH AND SUPPORT PROGRAM			
WEATHER BUREAU OFFICES	• COASTAL WEATHER AND WAVE FORECAST (1) • HIGH SEAS FORECAST (1) • TROPICAL CYCLONE FORECAST (1) • TROPICAL CYCLONE WARNING (1) • STORM SURGE AND ANOMALOUS TIDE (1) • SURF FORECAST (1) • DOMESTIC ICE FORECAST (1) • SEICHE WARNING (1) • AUTOMATIC COASTAL WAVE MONITORING (2) • COASTAL WAVE SPECTRAL AND STATISTICAL ANALYSIS (2) • SST ANALYSIS (2)	• COASTAL WAVE SPECTRA & WAVE STATISTICS (2) • COASTAL WAVE AND SURFACE METEOROLOGICAL CLIMATOLOGICAL DATA (2)	• COASTAL WAVE AND SURFACE METEOROLOGICAL PARAMETER ACQUISITION AND TELEMETRY NETWORK. • AUGMENTATION OF SERVICE C TELETYPEWRITER NETWORK FOR INCREASED DATA FROM BUOYS AND SHIPS

(1) Improvement of existing priority product, service or data base is required.

(2) New product, service or data base is required.

TABLE VII-1 (Cont'd.)
TECHNICAL DEVELOPMENT PLAN (PLAN C) SUMMARY OF PRIORITY PRODUCT/SERVICE, DATA BASE AND DATA ACQUISITION REQUIREMENTS, FY 70-81

AGENCY	PRODUCT/SERVICE REQUIREMENTS	DATA BASE DEVELOPMENT REQUIREMENTS	NEW DATA ACQUISITION/ COMMUNICATION SYSTEM REQUIREMENTS
FLEET NUMERICAL WEATHER CENTRAL AND NATIONAL METEOROLOGICAL CENTER	• HEMISPHERIC WEATHER PRODUCTS (FNWC AND NMC) (1) • WAVE HEIGHT FORECASTS (FNWC AND NMC) (1) • EXTENDED RANGE WEATHER FORECASTS (FNWC AND NMC) (1) • SST CHARTS (FNWC) (1) • THERMAL STRUCTURE FORECASTS (FNWC) (1)		• AIRCRAFT AND SHIP (NAVAL AND MERCHANT) DIGITAL COLLECTION AND TRANSMISSION OF SXBT, AXBT, STD, SEA STATE AND SURFACE METEOROLOGICAL DATA.
NATIONAL ENVIRONMENTAL SATELLITE CENTER	• SATELLITE CLIMATOLOGICAL PRODUCTS (1) • COMBINED SATELLITE/ METEOROLOGICAL DATA PRODUCTS (2) • SATELLITE DATA QUALITY CONTROL PROCEDURES (1) • COMPUTER GRAPHIC MODELING AND DISPLAYS OF SATELLITE AND METEOROLOGICAL DATA (2)	• SATELLITE DATA PRODUCT DESCRIPTOR FILES (2) • LINKAGE OF NESC AND NMC DATA BASES (2)	
FISHERIES PROGRAM			
BUREAU OF COMMERCIAL FISHERIES AND BUREAU OF SPORT FISHERIES AND WILDLIFE	• FISHERY ADVISORY (1) • ABUNDANCE FORECAST (1) • FISHERY PRODUCT REPORT (1) • FISHERY RESOURCE ATLAS (1) • FISHERY STATISTICS REPORT (1) • SPORT FISHERY ATLAS (1) • ESTABLISH NATIONAL SYSTEM OF REGIONAL DATA PROCESSING AND PRODUCT PREPARATION CENTERS FOR THE ABOVE PRODUCTS (2)	• FISHERY CATCH/EFFORT STATISTICS (1) • FISHERY ECONOMIC STATISTICS (1) • FISHERY EXPLORATORY GEAR DATA (1) • CORRELATION OF CATCH AND EFFORT STATISTICS WITH ENVIRONMENTAL DATA (2)	• NATIONAL SYSTEM OF REGIONAL FISHERY DATA COLLECTION AND COMMUNICATION CENTERS.

(1) Improvement of existing priority product, service or data base is required.

(2) New product, service or data base is required.

TABLE VII-1 (Cont'd.)
TECHNICAL DEVELOPMENT PLAN (PLAN C) SUMMARY OF PRIORITY PRODUCT/SERVICE, DATA BASE AND DATA ACQUISITION REQUIREMENTS, FY 70-81

AGENCY	PRODUCT/SERVICE REQUIREMENTS	DATA BASE DEVELOPMENT REQUIREMENTS	NEW DATA ACQUISITION/ COMMUNICATION SYSTEM REQUIREMENTS
WATER QUALITY PROGRAM			
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION	• GENERALIZED FILE MANAGEMENT AND INFORMATION RETRIEVAL SYSTEM FOR STORET (2) • REMOTE INQUIRY SYSTEM FOR STORET (2) • STORET SYSTEM FOR PROCESSING DATA COLLECTED ON-LINE FROM REMOTE SENSORS (2) • AUTOMATIC ON-LINE DETECTION OF WATER QUALITY CONDITIONS WHICH DO NOT MEET STANDARDS (2) • BEFORE AND AFTER ANALYSIS OF WASTE DISCHARGE AND WASTE TREATMENT OPERATIONS (2) • WATER QUALITY MODELS (2)	FOR STORET: • CONTINUED WATER QUALITY DATA COLLECTION FROM THE STATES AND REGIONS (1) • INDUSTRIAL WASTE DISCHARGE, OIL LEAK AND OIL SPILL DATA (2) • WATER QUALITY ECONOMIC DATA AND STATISTICS (2) • ENVIRONMENTAL DATA PRIOR TO AND AFTER WASTE DISCHARGE AND WASTE TREATMENT OPERATIONS (2)	• INSTALLATION OF SENSORS AND TELEMETRY SYSTEM FOR SELECTED ESTUARIES. • REMOTE TERMINAL COMMUNICATION.
ON SHORE BUOY DATA MANAGEMENT PROGRAM			
U.S. COAST GUARD	• SHORE PROCESSING CENTERS FOR BUOY DATA (2) • LAND COMMUNICATION FACILITIES FOR BUOY DATA (2) • BUOY DATA QUALITY CONTROL STANDARDS (2) • BUOY DATA FORMATTING AND EDITING (2) • SPACE TIME CORRELATION OF BUOY DATA (2)	• SYNOPTIC AND TIME SERIES DATA BASES FOR TEMPORARY STORAGE OF BUOY DATA (2)	• LAND BUOY DATA COMMUNICATION SYSTEM FROM SHORE FACILITIES TO FNWC AND NMC.

(1) Improvement of existing priority product, service or data base is required.

(2) New product, service or data base is required.

TABLE VII-1 (CONT'D)
TECHNICAL DEVELOPMENT PLAN (PLAN C) SUMMARY OF PRIORITY PRODUCT/SERVICE, DATA BASE AND DATA ACQUISITION REQUIREMENTS, FY 70-81

AGENCY	PRODUCT/SERVICE REQUIREMENTS	DATA BASE DEVELOPMENT REQUIREMENTS	NEW DATA ACQUISITION/ COMMUNICATION SYSTEM REQUIREMENTS
NATIONAL DATA CENTER PROGRAM			
NATIONAL OCEANOGRAPHIC DATA CENTER	• EXISTING SUMMARIES, PLOTS AND TABULATIONS (1) • NAMDI-NAPIS DIRECTORY/ INVENTORY CONTROL (1) • LIVE ATLAS (2) • COMPUTER GRAPHICS FOR MODELING (2) • OCEAN MODELS (2) • OCEAN ENGINEERING REFERRAL CENTER (2) • REGIONAL OFFICES (2) • REMOTE INQUIRY OF DATA BASES (2) • ON-LINE RETRIEVAL/ TELEPHONE ANSWERING SERVICE (2) • CRITERIA FOR ACCEPTANCE OF DATA (2)	• BT (1) • OCEAN STATION (1) • BIOLOGICAL (1) • GEOLOGICAL DATA INVENTORY (1) • SURFACE CURRENT (1) • DRIFT BOTTLE (1) • NAMDI-NAPIS (1) • CHEMICAL (2) • NEARSHORE (2) • STD (2) • SUBSURFACE CURRENTS (2) • SEDIMENT CHEMISTRY (2) • GEOTHERMAL (2) • SATELLITE (2) • BUOY (2) • SOUND VELOCIMETER (2) • UNDERWATER PHOTOGRAPHY INDEX (2) • OCEAN ENGINEERING (2) • STRUCTURE DATA BASES IN VARIOUS STORAGE LEVELS (DIRECT ACCESS, SERIAL ACCESS, ARCHIVAL, ETC) ACCORDING TO DEMANDS FOR DATA (2) • INCORPORATE INSTRUMENTATION DATA WITH DATA BASES (2) • INVENTORY OF OCEAN ENGINEERING DATA (2) • REMOTE LINKING OF NODC AND NWRC DATA BASES (2)	• "DATA ACQUISITION" FROM ORIGINAL COLLECTORS OF DATA FOR NEW DATA BASE DEVELOPMENT. • TELETYPE COMMUNICATION WITH REGIONAL OFFICES. • REMOTE TERMINAL COMMUNICATION WITH REGIONAL OFFICES. • MAGNETIC TAPE TO MAGNETIC TAPE COMMUNICATION WITH FNWC AND NWRC. • ON-LINE ACCESS TO NWRC DATA BASES.
NATIONAL WEATHER RECORDS CENTER	• CLIMATOLOGICAL ATLAS (1) • STORAGE AND RETRIEVAL SYSTEM FOR MSOF SYNOPTIC & TIME SERIES PRESENTATIONS (1) • MSOF AUTOMATED INDEX (2) • REGIONAL OFFICES (2) • REMOTE INQUIRY OF DATA BASES (2) • COMPUTER GRAPHICS FOR MODELING (2) • OCEAN ATMOSPHERIC MODELS (2) • CONTRIBUTE TO DEVELOPMENT OF COASTAL AND GREAT LAKES CLIMATOLOGICAL ATLASES (2) • SATELLITE DATA CLIMATOLOGICAL PRODUCTS (2)	• AUTOMATED MSOF INDEX FILE (2) • DATA AND DOCUMENTS INDEX FILE (2) • STRUCTURE DATA BASES IN VARIOUS STORAGE LEVELS (DIRECT ACCESS, SERIAL ACCESS, ARCHIVAL, ETC) ACCORDING TO DEMANDS FOR DATA (2) • REMOTE LINKING OF NODC AND NWRC DATA BASES (2)	• TELETYPE COMMUNICATION WITH REGIONAL OFFICES, FNWC, AND 14 WEATHER BUREAU OFFICES. • REMOTE TERMINAL COMMUNICATION WITH REGIONAL OFFICES AND WEATHER BUREAU OFFICES. • MAGNETIC TAPE TO MAGNETIC TAPE COMMUNICATION WITH FNWC. • ON-LINE ACCESS TO NODC DATA BASES.

(1) Improvement of existing priority product, service or data base is required.

(2) New product, service or data base is required.

TABLE VII-1 (Cont'd.)
TECHNICAL DEVELOPMENT PLAN (PLAN C) SUMMARY OF PRIORITY PRODUCT/SERVICE, DATA BASE AND DATA ACQUISITION REQUIREMENTS, FY 70- 81

AGENCY	PRODUCT/SERVICE REQUIREMENTS	DATA BASE DEVELOPMENT REQUIREMENTS	NEW DATA ACQUISITION/ COMMUNICATION SYSTEM REQUIREMENTS
SMITHSONIAN OCEANOGRAPHIC SORTING CENTER	• SPECIMEN-DATA-BIBLIOGRAPHY DIRECTORY (2) • STORAGE AND RETRIEVAL LANGUAGE (2) • PARTICIPATION IN REGIONAL OFFICES (2) • REMOTE INQUIRY OF DATA BASES (2) • IN-HOUSE INTERACTIVE TERMINAL (2)	• INFORMATION LINKAGES AMONG SPECIMENS, DATA AND BIBLIOGRAPHIES (2) • CONSOLIDATE COLLECTION, INVENTORY OF SAMPLES AND IDENTIFIED SPECIMEN FILES (2) • STRUCTURE DATA BASES IN VARIOUS STORAGE LEVELS ACCORDING TO DATA DEMAND (2) • DATA BASE COMPRESSION (2)	• REMOTE TERMINAL COMMUNICATION WITH REGIONAL OFFICES.

(1) Improvement of existing priority product, service or data base is required.

(2) New product, service or data base is required.

criticality of user need for data, products and services, and the unfulfilled needs for these data, products and services has been discussed in Chapters III and IV, Volume One. Major requirements for product and service improvement, data service improvement, data base development, data acquisition and communication, and new product and service development are discussed in Chapters IV and V of the Technical Development Plan. The highlights of recommended improvements in products and services and new products and services for each program area are presented below. The agency or lead agency (where several agencies are involved) which is recommended for implementation responsibility is indicated.

GREAT LAKES AND COASTAL DEVELOPMENT PROGRAM

- Implementation of a coastal wave gauge network for coastal U.S. waters of approximately 100 gauges for the recording of wave height and direction data. This network would be used and operated jointly by the Army Corps of Engineers, primarily the Coastal Engineering Research Center, for coastal engineering and research, and by the ESSA-Weather Bureau for coastal wave and weather forecasting and monitoring.

- Operation of the coastal wave gauge network in a non-real-time mode for coastal engineering purposes; real-time data acquisition and transmission would be required for Weather Bureau use.

- Development of a climatological atlas for the Great Lakes (Lake Survey).

- Completion of recreation chart coverage for the Great Lakes (Lake Survey).

- Development and production of ice atlases and charts, wave charts and atlases, surface current charts and bathymetric maps for the Great Lakes (LS and GLDC).

- Development of pollution, wave, ice and snow, surface currents, river flow and bathymetric data bases for the Great Lakes (LS and GLDC).
- Increased data processing and analysis capability for the Great Lakes Data Center and Coastal Engineering Research Center (one computer system at GLDC and one data acquisition and computer system at CERC).

MAPPING, CHARTING AND MARINE ENVIRONMENT DESCRIPTION PROGRAM

- Improvements in nautical and small craft chart geographic coverage and timeliness (C&GS and NAVOCEANO).
- Reduction in nautical chart resurvey frequency to 50 years by 1985 (C&GS).
- Bathymetric survey of 70 percent of the continental shelf (C&GS).
- Production of ocean engineering reports (NAVOCEANO,[1] CERC & USGS).
- Production of coastal atlas and coastal data collection (C&GS).
- Production of sea level variation charts and tables (C&GS).
- Increased use of automation--primarily computer graphics--in chart and map production (C&GS and NAVOCEANO).
- Installation of 5 shore-based computer systems (3 NAVOCEANO, 2 C&GS).
- Installation of 19 shipboard data acquisition and computer systems (12 NAVOCEANO, 7 C&GS) for hydrographic, bathymetric, geophysical and oceanographic surveys.

[1] Lead agency

- Establishment of a clearinghouse for the exchange of data between industry and other sectors of the marine community (USGS).
- Creation of geological product directories and ship track maps (USGS).

MARINE FORECASTING, RESEARCH AND SUPPORT PROGRAM

- Implementation and operation of a real-time coastal wave and surface meteorological data network (Weather Bureau Offices in cooperation with CERC).
- Installation of computer systems in 14 Weather Bureau Offices for processing of coastal wave and surface observation data (Weather Bureau Offices).
- Accelerated use of aircraft and ships (naval and merchant) for the collection of sea surface temperature, water temperature and salinity, sea state and surface meteorological data, emphasizing the use of expendable instruments and digital recording and transmission of the data.
- Installation of instrumentation aboard 10 aircraft, 304 naval ships, and 504 merchant ships, and communication of the data to the Naval Environmental Data Network and the Weather Bureau network is required by 1980 for the system. (It is recommended that there be joint responsibility for implementation between FNWC and NMC, with FNWC acting as lead agency for the Navy and NMC acting as lead agency for ESSA.)
- Integration of meteorological data (wind speed and direction, pressure, air temperature, sea surface temperature and sea state) with satellite products (digitized cloud mosaics, infrared sea temperature mappings, vertical temperature of the atmosphere profiles) (NESC).

- Linking of NESC and NMC data processing systems and data bases in order that the above integration of meteorological and satellite data may be accomplished (NESC).

- Development of computer graphics capability for analyzing and displaying hemispheric and global weather data collected by satellite (NESC).

- Development of satellite product descriptor files for use in ascertaining the nature and availability of satellite products and as an aid in the physical retrieval of archived satellite products (NESC).

- Development of techniques for the use of satellite data in climatological products (NESC).

FISHERIES PROGRAM (BCF and BSF&W)

- Establishment of a national fisheries data and product network consisting of BCF and BSF&W headquarters, regional BCF facilities, and local BCF and BSF&W facilities for data collection and processing and the preparation and distribution of fishery data products.

- Employment of the fisheries data network for the preparation and distribution of fishery advisories, abundance forecasts, fishery products reports, fishery resource atlases, fishery statistics reports and sportfishing atlases.

- Linking of regional and local BCF and BSF&W facilities by data communication; linking of regional facilities with the Department of the Interior computer center in Washington, D.C. by data communication.

- Installation of computer systems for 8 regional BCF facilities; communications terminals for 6 regional facilities (Honolulu and Auke Bay would communicate by mail) and 11 local facilities; and communication lines among 17 facilities and Washington, D.C.; are required for the fisheries data network.

WATER QUALITY PROGRAM (FWPCA)

- Establishment of increased capabilities for STORET, including generalized file management and information retrieval; inclusion of economic statistics, industrial waste discharge, oil leak and oil spill information in the data base; development of water quality models for use in predicting the effects of pollution.

- Establishment of remote sensor and telemetry systems operating from selected estuaries and transmitting data to the Department of the Interior computer in Washington, D.C. This system would be programmed to automatically detect and report water quality conditions which do not meet standards.

ONSHORE BUOY DATA MANAGEMENT PROGRAM (U.S. Coast Guard)

- Procedures and systems for storing, processing and distributing data to forecast centers and national data centers after data from the National Data Buoy Network reaches shore facilities.

- Procedures for the space-time correlation of buoy data prior to its transmission to forecast centers and national data centers.

- Installation of one shore-based computer system and communication facilities for Mod 0 buoy system and 22 shore-based computer systems and communication facilities for Mod 1 buoy system.

- Increases in the planned buoy reporting frequency after the buoy network has been established.

NATIONAL DATA CENTER PROGRAM

- Establishment of regional offices at 8 university sites to be manned and operated jointly by NODC, NWRC and SOSC personnel, with NODC as lead agency.

- Establishment of data communication links among:
    - NODC, NWRC and FNWC
    - NODC and 8 regional offices
    - NWRC and 8 regional offices
    - SOSC and 8 regional offices
    - NWRC and 14 Weather Bureau Offices
- Development of a live atlas and ocean and atmospheric models by NODC and NWRC.
- Linking of NODC and NWRC data bases.
- Restructuring of data bases at the 3 centers to store data at various levels (direct access, serial access and archival, e.g., microfilm) to reflect the demands for data retrieval.
- Designation of NODC as the developer and maintainer of the master national marine data directory for all marine data.
- Designation of NODC as the national ocean engineering data referral center for non-defense ocean-engineering data.
- Development of a number of data bases at NODC (see Table VII-1 for details).
- Creation of an automated marine surface observation file index at NWRC.
- Contribution to the development of coastal and Great Lakes climatological atlases (NWRC).
- Development with NESC of satellite data climatological products (NWRC).
- Development of a generalized information and storage retrieval system for the biological specimens which are processed by SOSC.
- Development of a marine specimen, data and bibliographic directory with cross-references among the three items (SOSC).

TECHNICAL DEVELOPMENT PLAN COSTS

Three types of costs are identified in the TDP:

1. Total yearly and ten-year agency costs.

2. Total ten-year costs which are required in order to implement the entire TDP or a portion of the TDP.

3. Total ten-year incremental costs which are required in order to implement the entire TDP or a portion of the TDP.

Costs in categories 2 and 3 have been developed for both programs and agencies. Costs in category 1 appear in Chapter IV of Volume Two for each agency. Incremental costs are not always explicitly shown for each agency in these tables because the purpose of the tables is to show total yearly and ten-year costs. These are the amounts which would have to be funded each year and for the ten-year period FY 71-80 in order to implement the TDP. An agency cost for one year or ten years is the sum of costs of new resources plus the cost of existing activities which are relevant to the TDP. Total ten-year costs are also equal to total FY 70 costs plus all increments in costs for personnel, hardware, and other items during FY 71-80.

A summary of the Technical Development Plan ten-year incremental and total costs is shown in Table VII-2 by program and agency. The incremental costs shown in the table are equal to total FY 80 costs minus ten times FY 70 costs. Therefore, an incremental cost is the increase [illegible] t which is required to implement the TDP when current budgets are held constant (level funding). The ten-year incremental costs are computed by program and agency in Table VII-3. The information used in the table to compute incremental costs has been obtained from the agency technical development plan specification exhibits of Chapter IV, Volume Two. The costs shown in Table VII-2 apply to

TABLE VII-2
SUMMARY OF TECHNICAL DEVELOPMENT PLAN (PLAN C)
TEN YEAR INCREMENTAL AND TOTAL COSTS

PROGRAM AND AGENCY	TEN YEAR INCREMENTAL COSTS (MILLIONS)	TOTAL TEN YEAR COSTS (MILLIONS)
GREAT LAKES & COASTAL DEVELOPMENT		
• LAKE SURVEY & GREAT LAKES DATA CENTER	$17.390	$23.390
• COASTAL ENGINEERING RESEARCH CENTER	5.130	7.216
	22.520	30.606
MAPPING, CHARTING & MARINE ENVIRONMENT DESCRIPTION		
• NAVAL OCEANOGRAPHIC OFFICE	90.620	211.670
• U.S. COAST & GEODETIC SURVEY	28.320	39.460
• U.S. GEOLOGICAL SURVEY	14.548	48.548
	133.488	299.678
MARINE FORECASTING, RESEARCH & SUPPORT		
• WEATHER BUREAU OFFICES	34.323	38.323
• NAVAL WEATHER SERVICE (MARINE DATA[1] ACQUISITION, TRANSMISSION & PROCESSING)	150.087	265.087
• ESSA (MARINE DATA[1] ACQUISITION, TRANSMISSION & PROCESSING)	57.147	117.147
• NATIONAL ENVIRONMENTAL SATELLITE CENTER	4.419	6.919
	245.976	427.476
FISHERIES		
• BUREAU OF COMMERCIAL FISHERIES & BUREAU OF SPORT FISHERIES & WILDLIFE	24.906	64.196
WATER QUALITY		
• FEDERAL WATER POLLUTION CONTROL ADMINISTRATION	12.690	22.210
ON-SHORE BUOY DATA MANAGEMENT		
• U.S. COAST GUARD	29.869	31.869
NATIONAL DATA CENTERS		
• NATIONAL OCEANOGRAPHIC DATA CENTER	13.082	38.082
• NATIONAL WEATHER RECORDS CENTER	9.468	21.761
• SMITHSONIAN OCEANOGRAPHIC SORTING CENTER	4.111	6.611
	26.661	66.454
TOTALS	$496.110	$942.489

[1] Sea surface temperature, water temperature and salinity profiles, sea state and surface meteorological parameters collected by ship (naval and merchant) and aircraft.

TABLE VII-3

COMPUTATION OF INCREASE IN 10-YEAR FUNDING
REQUIRED TO IMPLEMENT TECHNICAL DEVELOPMENT PLAN
(All cost figures are in millions of dollars)

<u>Great Lakes and Coastal Development Program</u>		
● Increase in GLDC data processing funds	$4.370	
● Increase in LS application personnel funds $19.020 (FY 80 Total) - 10 x $.600 (FY 70)	13.020	
●● Total increase in 10-year Lake Survey and GLDC funding		$17.390
● Increase in CERC data processing funds	4.216	
● Increase in CERC application personnel funds $3.774 (FY 80 Total) - 10 x $.286 (FY 70)	.914	
●● Total increase in 10-year CERC funding		5.130
●●● Total increase in 10-year program funds		$22.520
<u>Mapping, Charting and Marine Environment Description Program</u>		
● Increase in NAVOCEANO shore-based data processing funds	$8.488	
● Increase in NAVOCEANO shore-based application personnel funds $181.380 (FY 80 Total) - 10 x $12.105 (FY 70)	60.330	
● Increase in NAVOCEANO shipboard data acquisition and processing funds	21.802	
●● Total increase in 10-year NAVOCEANO funding		$90.620
● Increase in C&GS shore-based data processing funds	5.485	
● Increase in C&GS shore-based application personnel funds $19.785 (FY 80 Total) - 10 x $1.114 (FY 70)	8.645	
● Increase in C&GS shipboard data acquisition and processing funds	14.190	
● Total increase in 10-year C&GS funding		28.320
● Increase in USGS data processing funds	3.640	
● Increase in other[1] components of USGS marine data management budget which are required to support TDP $44.908 (FY 80 Total) - 10 x $3.400 (FY 70)	10.908	
●● Total increase in 10-year USGS funding		14.548
●●● Total increase in 10-year program funds		$133.488

[1] Primarily application personnel

TABLE VII-3 (CONT'D)

COMPUTATION OF INCREASE IN 10-YEAR FUNDING
REQUIRED TO IMPLEMENT TECHNICAL DEVELOPMENT PLAN
(All cost figures are in millions of dollars)

Marine Forecasting, Research and Support Program		
● Increase in Weather Bureau Office data acquisition, communication and processing funds	31.633	
● Increase in Weather Bureau Office forecasting personnel $6.690 (FY 80 Total) - 10 x $.400 (FY 70)	2.690	
●● Total increase in 10-year Weather Bureau Office funds		34.323
● Increase in Naval Weather Service[1] funds for marine data[2] acquisition, transmission and processing	113.200	
● Estimated increase in other[4] components of Naval Weather Service marine environmental observation and prediction which are required to support the TDP $151.887 (FY 80 Total) - 10 x $11.500 (FY 70)	36.887	
●● Total increase in 10-year Naval Weather Service marine data acquisition, transmission and processing funds		150.087
● Increase in ESSA[3] funds for marine data[2] acquisition, transmission and processing	37.905	
● Estimated increase in other[4] components of ESSA marine environmental observation and prediction which are required to support the TDP $79.242 (FY 80) - 10 x $6.000 (FY 70)	19.242	
●● Total increase in 10-year ESSA marine data[2] acquisition, transmission and processing funds		57.147
● Increase in NESC data processing funds	3.605	
● Increase in other[4] components of NESC marine data $3.314 (FY 80 Total) - 10 x $.250 (FY 70)	.814	
●● Total increase in 10-year NESC funds		4.419
●●● Total increase in 10-year program funds		$245.976

[1] FNWC is recommended lead agency

[2] Acquisition, transmission and preliminary processing of sea surface temperature, water temperature, sea state and surface meteorological parameters obtained from ships and aircraft

[3] NMC is recommended lead agency

[4] Primarily application personnel costs

TABLE VII-3 (CONT'D)

COMPUTATION OF INCREASE IN 10-YEAR FUNDING
REQUIRED TO IMPLEMENT TECHNICAL DEVELOPMENT PLAN
(All cost figures are in millions of dollars)

Fisheries Program		
• Increase in BCF and BSF&W data collection, communication and processing funds	12.251	
• Increase in BCF and BSF&W application personnel funds $51.945 (FY 80 Total) - 10 x $3.939 (FY 70)	12.655	
•• Total increase in 10-year BCF and BSF&W and program funds		$24.906
Water Quality Programs		
• Increase in FWPCA data acquisition, communication and processing funds	9.627	
• Increase in FWPCA application personnel funds $12.583 (FY 80 Total) - 10 x $.952 (FY 70)	3.063	
•• Total increase in 10-year FWPCA and program funds		$12.690
On-Shore Buoy Data Management Program		
• Increase in U.S. Coast Guard data processing and communication funds	29.232	
• Increase in U.S. Coast Guard Data Buoy Project Staff funds $2.637 (FY 80 Total) - 10 x $.200 (FY 70)	.637	
•• Total increase in 10-year U.S. Coast Guard and program funds		$29.869

TABLE VII-3 (CONT'D)

COMPUTATION OF INCREASE IN 10-YEAR FUNDING
REQUIRED TO IMPLEMENT TECHNICAL DEVELOPMENT PLAN
(All cost figures are in millions of dollars)

<u>National Data Center Program</u>		
● Increase in NODC equipment and software development funds	5.058	
● Increase in other* components of NODC operations which are required to support the TDP $33.024 (FY 80 Total) - 10 x $2.500 (FY 70)	8.024	
●● Total increase in 10-year NODC funds		13.082
● Increase in NWRC equipment and software development funds	5.506	
● Increase in other* components of NWRC operations which are required to support the TDP $16.282 (FY 80 Total) - 10 x $1.232	3.962	
●● Total increase in 10-year NWRC funds		9.468
● Increase in SOSC equipment and software development funds	3.297	
● Increase in other* components of SOSC operations which are required to support the TDP $3.314 (FY 80 Total) - 10 x $.250 (FY 70)	.814	
●● Total increase in 10-year SOSC funds		4.111
●●● Total increase in 10-year program funds		$ 26.661
●●●● Total increase in 10-year funding required in order to implement Technical Development Plan		$496.110

* Primarily applications personnel

the technical development plan which was summarized in the previous section. This plan is referred to as "Plan C" in order to distinguish it from Plan A and Plan B which are described in Chapter VI, Volume One. These are alternate plans which are available in the event that the funds required for the implementation of Plan C are not available. Plan A and Plan B were formulated with the aid of a cost/performance model which is described in Chapter VI, Volume One. These plans have not been developed to the level of detail present in Plan C. The plans are stated in terms of product and data service performance levels and costs. The cost allocation outputs of the model could be employed to formulate additional detailed TDP plans in terms of equipment, personnel and other resources.

Plan C was developed by the methodology described in this chapter. The ten-year incremental cost of this plan is $496 million; the ten-year total cost is $942 million. During the decade, FY 71-80, the costs range from $66 million in FY 70 to $111 million in FY 80. The compound annual growth rate of the total yearly budget from FY 70[1] to FY 80 is 9 to 10 percent. Ten-year incremental costs of this plan ($496 million) are 5 percent of the ten-year incremental funds ($10 billion) recommended for NOAA by the Marine Commission. The current portion of the total Federal Marine Science Program (FY 70) expended on priority marine data and products is 8.5 percent ($44.7 million out of $528 million).

The allocation of ten-year incremental costs to program areas is shown in Table VII-4. The allocation of costs shown in the table could be misleading. The large amount allocated to marine forecasting, research and support would provide benefits to several other program areas in addition to marine forecasting. The mounting of a large scale surface and subsurface data collection program would also provide benefits to programs in environmental description (data for the production of environmental description products) fisheries (temperature, salinity and meteorological data for fisheries research and

[1]The FY 70 priority marine data management budget is estimated to be $44.718 million.

operations), national data centers (a significant new source of data), and coastal development (data collection for development of coastal atlases and other products).

TABLE VII-4

ALLOCATION OF TEN-YEAR INCREMENTAL COSTS TO PROGRAM AREAS

PROGRAM	INCREMENTAL FUNDS ($MILLIONS)	PERCENT
• GREAT LAKES AND COASTAL DEVELOPMENT	$ 22.520	4.54
• MAPPING, CHARTING AND MARINE ENVIRONMENT DESCRIPTION	133.488	26.91
• MARINE FORECASTING, RESEARCH AND SUPPORT	245.976	49.58
• FISHERIES	24.906	5.02
• WATER QUALITY	12.690	2.56
• ONSHORE BUOY DATA MANAGEMENT	29.869	6.02
• NATIONAL DATA CENTERS	26.661	5.37
	$496.110	100.00

Schedules for the implementation of agency development plans are contained in Chapter IV of Volume Two. The implementation priority of the elements of the TDP is specified by the sequence in which activities are scheduled. Requirements for interagency cooperation are indicated in the agency development plans. A mechanism for achieving coordination within the context of the entire marine data network is summarized in the following section and is described in greater detail in Chapter V of Volume Two.

MARINE DATA NETWORK DEVELOPMENT PLANS

To achieve the degree of coordination required to implement this Technical Development Plan, a mechanism must be established which would be responsive to both the day-to-day and long-range planning operations. During the course of the study, the contractor found it invaluable to have one central office--the Marine Science Council--with which planning and policy formulation could be conducted, and the Data Management Advisory Panel (DMAP). It is therefore recommended that one office be designated for cognizance of policies applicable to marine data management activities, and that DMAP be continued on a permanent basis.

Specific suggested responsibilities for the first office should include the following major areas of responsibility:

-- Monitoring implementation of marine data program improvements to compare the results with objectives.

-- Expediting availability of relevant data program information to the affected marine community including proprietary, classified, and other marine data.

-- Forecasting data program requirements.

-- Assessing the routing of data among marine data acquisition, processing, and dissemination agencies and the distribution of workloads among the various marine data facilities.

-- Updating the Technical Development Plan for the national marine data management program to ensure its currency with events.

-- Coordinating marine data and product service operations involving multiple agencies.

-- Fostering flow of marine data to and among national centers.

-- Improving interagency compatibility.

-- Reducing redundancies in marine data holdings, product generation, and service operations.

-- Facilitating marine data and product inventories and accountability.

It is suggested that the appropriate designation of the first office be within the Executive Office of the President, more particularly in the Marine Science Council, unless and until a new office or agency is formed for the purpose of coordinating national marine science activities.

Based upon the nature and scope of these activities, this proposed national coordinating mechanism for marine data management programs should have the capability for providing in an ongoing manner the information necessary for national level:

-- policy planning
-- program planning
-- fiscal planning
-- decision making
-- progress monitoring

The specific responsibilities of the DMAP would be those of technical review of progress and agreement on solutions to problems that arise in implementation of improved data management programs. For example, establishment of standards for quality control in the collection of marine data, standards for compatibility of formats in data modification and inventory control, scales for map and chart production, new marine data product specifications, and means for achieving real-time linkages among computer-based files of marine data would be appropriate for this Panel.

APPENDICES

CONTENTS

Appendix

ENVIRONMENTAL FORECASTING

ESSA Weather Bureau
Silver Spring, Maryland
- Mr. Max Mull
- Mr. Arthur Pore
- Dr. Sidney Twewles
- Mr. James Giraytys
- Mr. Warren Hight

ESSA Weather Bureau
Garden City, New York
- Mr. Gerald Shak
- Mr. Eugene Kilgore
- Mr. Henry Rockwood
- Mr. William McKee

ESSA Weather Bureau
National Meteorological Center
Suitland, Maryland
- Mr. Clapp
- Dr. Adem
- Dr. Burnett
- Mr. O'Connor
- Mr. Fawcett
- Mr. Drewes
- Dr. Namias

ESSA
National Environmental Satellite Center
Suitland, Maryland
- Mary Ann Ruzecki
- Dr. Paul McLean
- Mr. Art Schwalb
- Mr. Robert Popham

ESSA Weather Bureau
Miami, Florida
- Mr. Arnold Sugg
- Mr. Jesse Gulick

ESSA Weather Bureau
Boston, Massachusetts
Tenth Annual New England Marine Weather Meeting
- Mr. William McKee, et al

U.S. Coast Guard
Governors Island, New York
- Chief Van Gaasbeck
- Lt. John Greason

ESSA Weather Bureau
San Francisco, California
- Mr. Gustafson

ESSA Weather Bureau
Los Angeles, California
- Mr. Gordon Shields

Naval Weather Service
Washington, D.C.
- Commander C. R. Junghans
- Commander C. P. Pfarrer, Jr.
- Mr. R. H. Martin
- Chief Parker

Naval Fleet Weather Central
Norfolk, Virginia
- Commander C. R. Ward

NAVOCEANO Oceanographic Prediction Division
Washington, D.C.
- Mr. R. McGough
- Mr. George Hanson

Fleet Numerical Weather Central
Monterey, California
- Captain Paul Wolff
- Commander Glenn Hamilton
- Dr. Tavio Laevastu
- Mr. Stevens
- Lt. Cdr. B. E. Bradford
- Lt. N. S. Perkins

Fleet Weather Central
Oakland, California
- Commander W. C. Palmer
- Commander R. A. Lina
- Lt. T. H. Calhoon
- Mr. George Hammond

Fleet Weather Facility
San Diego, California
- Commander R. C. Olson
- Lt. Betancourt

ESSA Plans and Programs
- Mr. J. A. Mirabito

ENVIRONMENTAL DESCRIPTION

ESSA U.S. Coast and Geodetic Survey
Rockville, Maryland
- Captain Steve Hollis
- Mr. Steacy Hicks
- Mr. Robert Cummings
- Mr. Charles Muirhead
- Mr. Mark Spaeth

ESSA Environmental Data Service
Silver Spring, Maryland
- Dr. Woodrow Jacobs
- General Ben Holtzman
- Mr. Arthur Cooperman
- Mr. Herbert Myers

National Weather Records Center
Asheville, North Carolina
- Mr. William Haggard
- Mr. Keith D. Butson
- Mr. Grady McKay

ESSA Coast and Geodetic Survey
- Mr. Wallace A. Bruder
- Mr. Lewis V. Evans, III
- Mr. Herbert W. Burgoyne
- Mr. John McAlindin
- Mr. Steacy Hicks
- Miss Martha A. Winn
- Mr. Charles B. Taylor
- Captain Benton
- Mr. Herman C. Anderson
- Mr. Earl W. Rayfield
- Mr. Max McLean
- Mr. James H. Nelson
- Mr. A. J. Bilik
- Mr. D. A. Rice
- Mr. Ernest Thomas
- Mr. M. J. Yellin
- Captain Steven Hollis

U.S. Lake Survey
Detroit, Michigan
- Major Hall
- Mr. L. D. Kirshner
- Mr. F. A. Blust
- Mr. J. S. Moore
- Mr. A. W. O'Dell
- Mr. C. B. Feldscher
- Mr. L. Bajorunas
- Mr. R. J. Walton
- Mr. A. W. Hodson
- Mr. J. G. Housley
- Mr. A. P. Pinsak
- Mr. Don Rondy
- Mr. Bottiger
- Mr. Stanley Bolsinja

Naval Oceanographic Office
Washington, D.C.
- Captain Macomber
- Mr. V. T. Miscoski
- Mr. A. S. Basile
- Mr. Ron M. Bolton
- Mr. Fonfara
- Mr. Pruitt
- Mr. Nahas
- Mr. O. L. Martin
- Mr. F. W. Fricker
- Mr. J. C. Martin
- Mr. Cannon
- Mr. McCahan
- Mr. D. K. Jenkins
- Captain Miller
- Mr. Foster
- Mr. John Sylvester
- Mr. Hamblem
- Mr. Zurad
- Mr. Miles
- Mr. Atwood
- Mr. W. E. Hart
- Miss Tippetts
- Mr. A. R. Gordon
- Mr. W. R. Deebel
- Mr. Land
- Mr. Wilcox
- Mr. Newsom
- Mr. Moore
- Mr. Baker
- Mr. Chabot
- Mr. G. A. Young
- Mr. F. N. Waits
- Mr. G. L. Johnson

NAVAL OPERATIONS

Office of Chief of Naval Operations
Washington, D.C.
Captain A. T. Nicholson, Jr.
Captain Walter A. Akins
Captain J. E. Ackerman

Naval Ship Systems Command
Washington, D.C.
Mr. A. P. Francishetti

Naval Ordnance Systems Command
Washington, D.C.
Mr. J. F. Ropek

Antisubmarine Warfare Group 5
Long Beach, California
Lt. Cdr. Walter Glenn

Submarine Development Group One
San Diego, California
Lt. Cdr. Bartels

Commander, Amphibious Forces of the Pacific
Coronado Island, San Diego, California
Lt. Cdr. Jack Bengel

Antisubmarine Warfare Helicopter Squadron
Imperial Beach, California
Lt. R. T. Montana
Lt. C. W. Oakes
Lt. J. W. O'Brien

Oceanographer of the Navy
Alexandria, Virginia
Mr. Fred Small
Mr. Marvin Burkhart
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Captain R. A. Zettel
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Mr. R. H. Randall, Jr.
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Mr. W. H. Geddes
Mr. E. F. Lou
Mr. L. R. Kelly
Mr. G. Leonard Johnson
Mr. A. L. McCahan
Mr. Arthur Alexion

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Mr. H. W. Dubach
Mr. R. M. Holcombe
Mr. H. C. Felt
Mr. R. J. McGough
Dr. R. W. James
Miss D. Jean Keen

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Mr. Norman Johnson
Mr. Milton J. Lohr, Jr.
Mr. A. L. McCahan

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COMSUBFORLANT
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Governors Island, New York
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Coral Gables, Florida
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Annapolis, Maryland
Mr. George J. Murphy

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Governor's Conference on Massachusetts
Stake in the Ocean
Boston, Massachusetts

Coastal Plains Regional Commission
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11th Conference on Great Lakes Research
Milwaukee, Wisconsin

Louisiana State Geological Survey
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Louisiana State Mineral Board
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Board of Conservation
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Railroad Commission
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Seattle, Washington
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Mr. Luther Gulick
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Los Angeles Regional Water Quality Control Board No. 4
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Mr. Ronald G. Hansen

San Diego Regional Water Quality Control Board
San Diego, California
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Department of Organismic Biology
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APPENDIX B

MARINE DATA QUESTIONNAIRE

(EXAMPLE)

NAVAL PLANNER AND OPERATOR

MARINE DATA QUESTIONNAIRE

April 1968

Part I - Needs of Data Service Customers

Phase II of National Data Program for the Marine Environment

System Development Corporation
2500 Colorado Avenue
Santa Monica, California 90406

MARINE DATA QUESTIONNAIRE

April 1968

Section	Subject
A	General Information
B	Data Use/Needs
C	Data Collection
D	Data Flow Process
E	Data Service Economics

Attachment A - Partial List of Data Types

Attachment B - Data Formats

NOTES:

1. Daily sea reports are not dense enough in coverage; therefore data grouped for a longer time period are used to provide sufficient coverage to permit analysis.
2. Major problem is getting all stored data together chronologically. It is stored geographically, or according to cruise--not chronologically.
3. Data are not available in depth from sparsely travelled regions.

MARINE DATA QUESTIONNAIRE

A. GENERAL INFORMATION

1. Date 1968 5 1
Year Month Day

2. Interviewer

3. Time Started 1330 Time Completed 1600

4. Interviewee Name

5. Title Evaluation Group Head-ASWEPS Oceanographic Prediction Div.
Marine Science Dept.

6. Phone Number

7. Organization Name NAVOCEANO (U.S. Naval Oceanographic Office)

8. Address Building 160 WNY

9. Organization Mission and Goals

Development of techniques to predict acoustic ranges from synoptic thermal ocean data. This is used for ASWEPS. Development of Ice Prediction techniques (another group).

10. Organization Functions

1) Techniques for Acoustic Range Prediction.
2) Preparation of thermal charts, graphs, etc., predicting acoustic ranges.
3) Preparation of ICG Prediction Charts.

Prepares products for Fleet use.

Which of the following categories describe the organization's current (C) activities? Projected (P) activities?

11.		RESOURCE DEVELOPMENT	27.	X	OCEANOGRAPHIC PREDICTION
12.		Mineral	28.		MAP and CHART PREPARATION
13.		Petroleum	29.	X	APPLIED RESEARCH
14.		Chemical	30.		BASIC RESEARCH
15.		Food	31.		Physical Oceanography
16.		Drug	32.		Chemical Oceanography
17.		Other (specify	33.		Biological Oceanography
			34.		Geology & Geophysics
18.		ENGINEERING	35.		Air-Sea Interaction
19.		Marine	36.		Other (specify)
20.		General Ocean			
21.		Coastal	37.		LEGAL
22.		CONSERVATION	38.	X	DEFENSE and SPACE
23.		RECREATION	39.		DATA CENTER
24.		HEALTH and WELFARE	40.		INSTRUMENT DEVELOPMENT
25.	X	TRANSPORTATION	41.		EQUIPMENT DEVELOPMENT
26.	X	SYNOPTIC OCEANOGRAPHY	42.		OTHER (specify

43. Copy of organization chart showing names of departments and department heads, and the relationship each department has in the organization's marine operations. See U.S. Naval Oceanographic Office desk list.

(03) Oceanography - Capt. Treadwell
(30) Marine Science Dept. - A. R. Gordon
(3400) Oceanographic Prediction Division - R. J. McGough
(3405) Evaluation

44. Additional description of organization (including size) and interests (including geographic areas).

Approximately 86 people - Oceanographic Prediction Division

Arctic } Ice Prediction
Antarctic }

Western North Atlantic only for ASWEPS

Indicate whether the following pertains.

45. X Collector of marine data

46. X User of marine data

47. X Processor/disseminator of marine data (data center)

48. X Disseminator of marine data

Are there limitations on the collection, use, processing, or dissemination of data? If so explain below.

49. Political, (e.g., limitations on extent of data collection and processing activity due to agency charter.) Limited to Western North Atlantic- except for ice predictions.

50. Legal, (e.g., restrictions on the placement of buoys in traveled sea lanes.) None

51. Economic, (e.g., budget limitations; data processing equipment too costly.) None

52. Technological, (e.g., data processing technology not sufficiently advanced to solve data handling problems.) None

53. Physical, (e.g., data processing workload exceeds capacity of available equipment.) None

54. Other (specify) None

55. Have prior studies concerning data management been made by the organization? No If so, are they published? - Are they available to SDC? - Identify them and the sources for obtaining them.

56. What are the current plans of the organization concerning data management? If available in printed form, is a copy available to SDC? ________ If not printed, provide a description here.

Doesn't know of any data management plans

57. Is interviewee aware of new sampling programs, instruments, or systems now under development which will provide additional data in large volume in the future? If so, describe and estimate the volume and the time when this volume will occur.

Type	Volume	Time
Monster Buoy Program	Large	Near future
Expendable STD	Large Volume	Hasn't been proven yet, under study
ART (digitizing	Large	Under study

58. Is interviewee aware of potential needs for data that might place new or increased requirements on current data services? If so, describe and estimate the changes and the time when they will occur.

Just normal additions of data. All instruments will be going deeper in next 5-10 years.

Expect more wave data and ice data from satellites.

59. Are data exchanged with or needed from other countries? If so, which?

Data Type	Organization	Country	Exchanged or Needed
ice	[illegible]O, ESSA		needed

60. What types of regular data publications are needed? (Example: bibliographies, progress status reports, work in process, cruises planned, etc.) None. Interested only in Synoptic Data

Data Type	Report Form	How Often?	From What Organization?

Requires very little historical data - have been working with ASWEPS for over five years and keeps track of daily synoptic data. NODC keeps the records for ASWEPS as this information was turned over to NODC when NODC started. Sometimes goes to NODC and physically finds raw data (backlog to be reduced) and reduces it when required.

61. What is the organization's system (either automated or manual) for document indexing, storage, and retrieval? Is the index system documented? No If so, are copies available to SDC for loan or retention? X Identify them and the sources for obtaining them.

Data is received at NODC and is logged on microfilm.

Data is read from microfilm when required and that not microfilmed is manually dug out of storage.

62. Indicate the interviewee's appraisal of the number, size, and identity of other organizations with overlapping or similar areas of interest.

1) Works well with FWC-Norfolk,

2) The ASWEPS Group at Norfolk andwith 3) FNWF, Monterey.

4) BCF interested in synoptic tem. salinity

5) ESSA interested in synoptic temp. salinity

6) Coast Guard synoptic Ice

B. DATA USE/NEEDS TABLE

CURRENT AND PROJECTED

ITEM	DATA DESCRIPTION	STATUS	AVAILABLE — USED	
1	Purpose of Data Use[a] (e.g., locate fish)		Acoustic Range determination Ice Prediction	
2	Type (per attachment A)			
3	Where collected?		N.W. Atlantic - Arctic, Antarctic	
4	Format (per attachment B)			
5	From Whom Received? Was International Exchange Involved?		Fleet, Commercial, RCN (Canada) RN (GB), Private	
6	Mode of Transmission from Supplier (Mail, Radio, etc.)		Institutions, Aircraft, Buoys, FNWC Radio and Teletype	
7	Frequency of receiving data (e.g., weather reports received daily)		1-6 reports per day	
8	Volume - Present use and estimated future use (e.g., 100 cores used per year)	1967	250 BT per day 8000 surface reports	
		1968		
		1969	Similar, but probably in other areas	
		1970	Salinity would be in large volumes if instrument	
		1975		
		1980		
9	Preprocessed prior to receipt? How? (e.g., Sensor Instrument, Computer)		by hand	

10	Classified?	no				
11	Proprietary?	-----				
12	Transmission Time from Data Supplier to User	Every 6 hours				
13	What delays in receiving data from other sources have been experienced and why?	2-3 days (not sure)				
14	What delay in receiving data from other sources is acceptable?	[illegible]				
15	What are requirements on data quality? (e.g., Accuracy, Precision, etc.)	[illegible] 1 NM (geographical) 1 ft. ([illegible])				
16	Value to user to have desired data (in dollars)	----				
17	Other users of same data? Specify (b)	[illegible] distributed [illegible] by [illegible]				
18	How many requests received from other users? (i.e., No./Year)	[illegible]				
19	Remarks about data services and products. (Why are data not used? Why are unavailable data desired?)	[illegible] chronologically as well as geographically				

(a) Indicate Current by C and Projected by P.

(b) Identify users as students, consultants, small businesses, or by other lay-designation.

Individual Furnishing Information:
Name [illegible] Title Evaluation - ASWEPS-NAVOCEANO

C. DATA COLLECTION

Organization ASWEPS-NAVOCEANO

Individual Furnishing Information
Name ______ Title Evaluation

Item		Current Method			Projected Method	
1.	Purpose of Data Collection [a] (e.g., Biological Survey)	Acoustic Prediction Ice Prediction				
2.	Duration of Collection Activity (e.g., Jan - Mar 1968)	Acoustic (all year) Ice (seasonal)				
3.	Geographic Area of Survey (e.g., N. Pacific)	N.W. Atlantic Artic Antartic				
4.	Data Type (per Attachment A)[b]					
5.	Data Format (per Attachment B)					
6.	Method of Collection a) Sensor or Instrument (e.g., Nansen Cast, BT, etc.) b) Time/Space Distribution of Data (i.e., synoptic or time series)	Airborne Radiation therm. (ALF) BT (Bathy) SST (CIRM) Salinity (ocean) - some			Monster Buoy Satellite	
7.	Collection Device Manufacturer and Model No.	---				
8.	Platform Used (e.g., Ship, Buoy Rig)	Ship buoy	A/C			
9.	Frequency of Data Surveys by Ship or other Collection Platform (e.g., 3 per year average)					
10.	Sample Size and Frequency of Sampling (e.g., 15BT slides, 6X/day)	250 BT per day all sources				
11.	Daily Period of Collection (e.g., 1000 to 1400)	----				
12.	Frequency of Radio Transmissions to Shore (e.g., 6 per day)	----				
13.	Are any reports on data held for transmittal until reaching port? Explain	RATT, then mailed to NODC				
14.	Time required for Transmission to Shore Station (e.g., 2.5 hours)	----				
15.	Local Time of Transmission (e.g., 1800)	----				
16.	Mode of Transmission to Shore Station (e.g., Radio teletype, Mailed upon reaching shore, etc.)	(RATT)				
17.	Quality (i.e., Accuracy, Precision)	Good				

C. DATA COLLECTION (contd)

Item			Current Method	Projected Method
18.	Volume - Presently Collected and Estimated future Collection (e.g., 1,000 Nansen Casts per Year)	1967	SST- 8000 every 6 hours BT - 250, 500 radiosunds/12 hours	
19.		1968		
20.		1969	same	
21.		1970		
22.		1975		
23.		1980		
24.	Preprocessing Prior to Recording and Storage? How? (e.g. Sensor Instruments, Computers, Manual, etc.)		Hand	
25.	Classified?		No	
26.	Proprietary?		--	
27.	Who uses data?		ASWEPS Forces	
28.	Remarks About Problems in Data Collection		Not enough geographic coverage	

(a) Does organization participate in cooperative cruises and surveys (local, state, national, international)? no.

(b) Are examples of marine data types collected by the organizations available to SDC? no. If so, identify the sources for obtaining them.

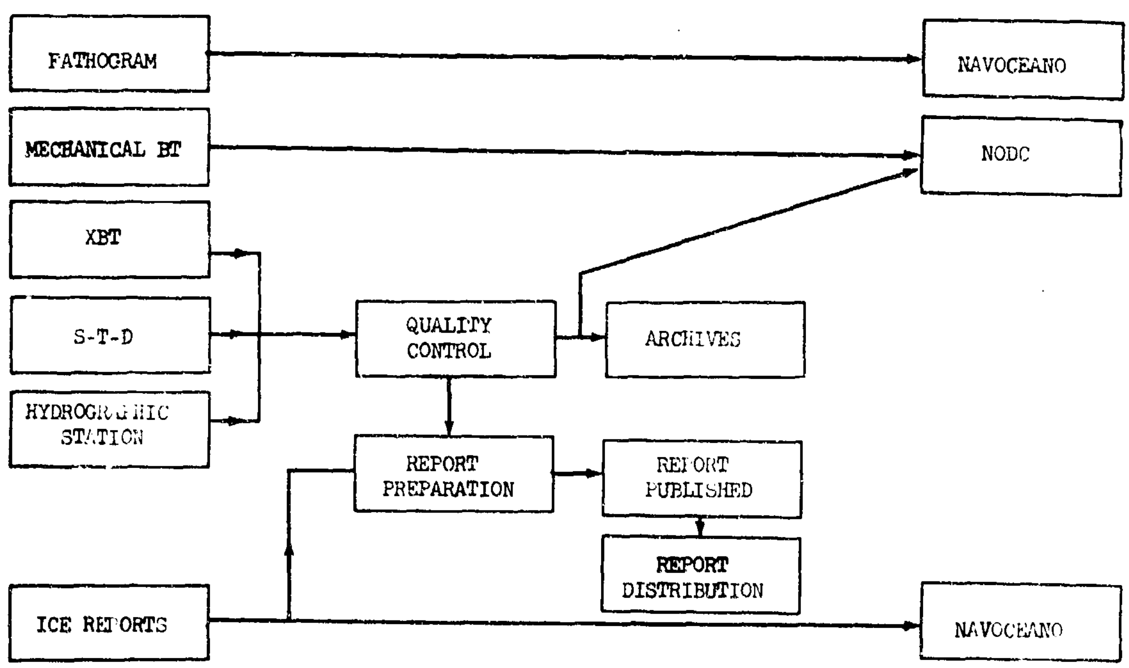
D. DATA FLOW PROCESS

Fill out the attached Data Flow Summary for organizations that collect and transmit data to other users.

In addition, include a schematic diagram of the data flow from this organization to other organizations. A sample Schematic Data Flow Diagram is provided below.

SCHEMATIC DATA FLOW DIAGRAM

COAST GUARD OCEANOGRAPHIC DATA

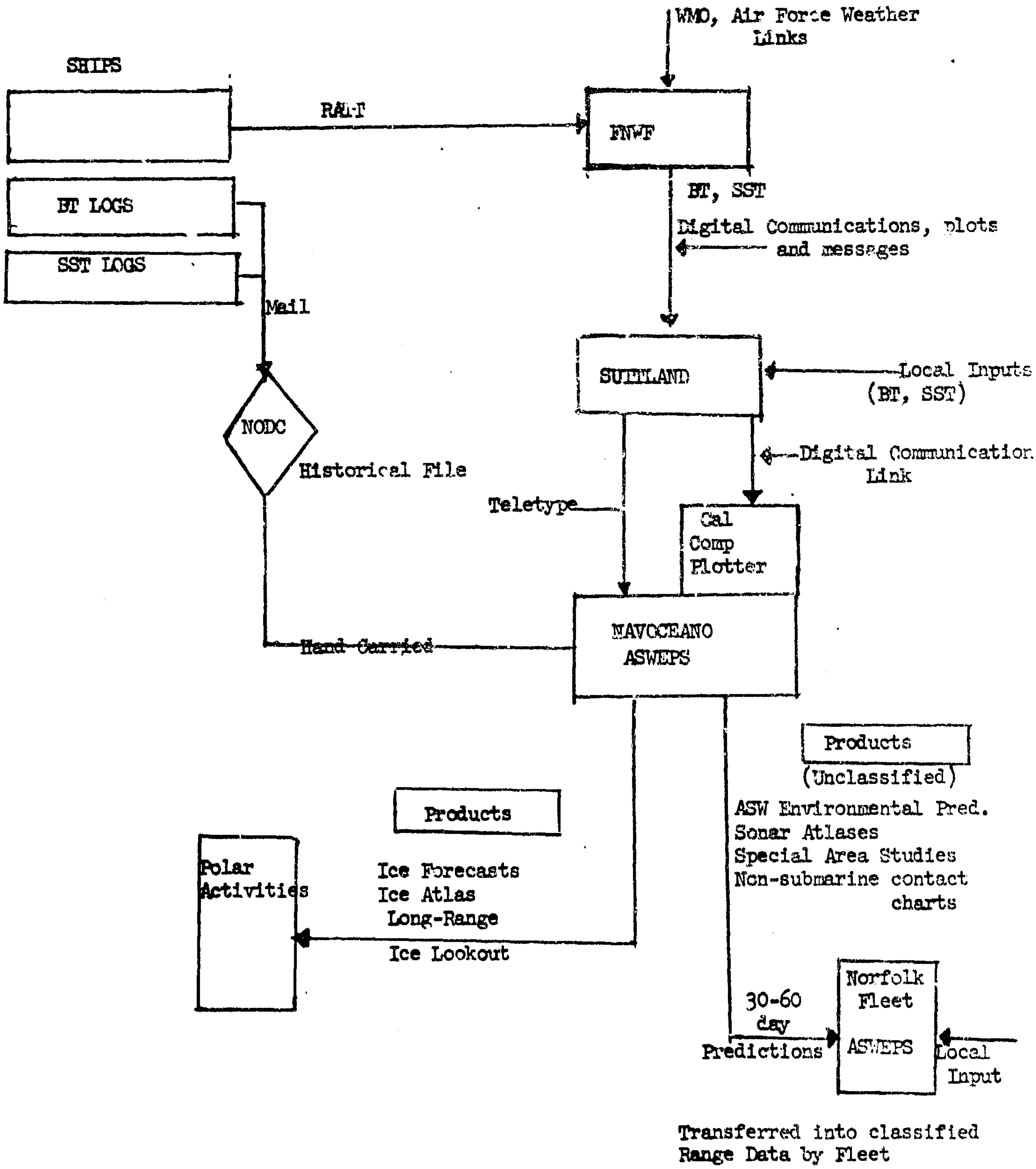


DATA FLOW SUMMARY

	Current System		Projected System	
1. Collecting (and Transmitting) Organization	FNWF			
2. Receiving Organization	SUITLAND			
3. Data Type (per Attachment A)				
4. Data Format (per Attachment B)				
5. Mode of Transmission (e.g., Radio, Mail, etc.)	Radio telephone link			
6. Data Volume per Transmission	250 BT) 8000 SST)	Sent all day		
7. Frequency of Transmittals	"	"		
8. Time Required for Transmission to Requesting Agency	-----			

SCHEMATIC DATA FLOW DIAGRAM

ORGANIZATION ASWEPS - NAVOCEANO



E. DATA SERVICE ECONOMICS

Cost and user benefit indices are required for each data acquisition program for which they can be obtained. Listed below are some typical data handling acquisition cost elements. Ascertain the organization's classification (i.e., breakdown) of cost items and expand or modify the table accordingly. Where actual cost figures are not available, approximations to the relative costs should be determined. A measure of the user benefits derived from each cost element, or other suitable acquisition or service factor, should be indicated using any convenient units such as dollars or fraction of the total benefit, or simply a narrative discussion.

UNKNOWN

COST ELEMENT	COST		USER BENEFIT
	Annual Dollars	Relative	
Total Program	$	100%	
Data Collection			
Operation of Platform (people and equipment)			
Instrumentation equipment			
Data Processing (people and equipment)			
Data Use Research			
Planning			
Management			
Operations			

E. DATA SERVICE ECONOMICS (Continued)

In addition, attempt to identify any efforts the organization may be planning for the purpose of establishing a data base for its marine activities. Describe those below.

None

ATTACHMENT A

PARTIAL LIST OF DATA TYPES

Data Normally Recorded Regardless of Measurements Made

Ship Name
Cruise
Project Manager
Ship Heading and Speed
Time

Geographical Location
Depth
Sea State
Weather Conditions
Others

Physical

Pressure
Temperature
Water Density
Horizontal Current Direction
Horizontal Current Velocity
Vertical Current Velocity
Tidal Period
Tidal Height
Internal Tide
Wave Length
Wave Period
Wave Height
Wave Direction
Swell, Period Height and Direction
Surf Conditions

Nansen casts
Wave Surge
Explosive Waves
Tsunami Wave Record
Drift Bottle Position
Long-Period Oscillations
Mechanical BT
Expendable BT
S-T-D
Fresh Water Inflow
Dye Tracer Concentration
Sediment Settling Rate
Water Eh
Seabed Drifter Position
Internal Wave Parameters
Others

Chemical

Salinity
Nutrients
- Nitrates
- Nitrites
- Phosphate
- Silicate

Carbonate
Sulphate
Chloride
Dissolved Gas
- Oxygen
- Carbon Dioxide
- Helium
- Ammonia
- Hydrogen Sulfide

Radioactivity
- Oxygen -18
- Carbon -14
- Strontium -90

Metals - list under 'others'
Non-Metals - list under 'others'
Rare Elements (Rubidium, Uranium)
pH
Alkalinity
Acidity
Particulate Matter
Vitamins
Dissolved Organics
Others

ATTACHMENT A
cont'd

Biological

- Kingdom - Animalia, Plantae, Protista
  - Subkingdom
    - Phylum
      - Class
        - Order
          - Genus
            - Species
- Phytoplankton
- Zooplankton
- Bacteria
- Protozoa
- Algae
- Diatoms
- Rotifers
- Insects
- Crustacea
- Mollusca
- Coral
- Other Invertebrates
- Fish
- Marine Mammals
- Photographs
- Specimens
- Fouling Organisms
- Bioluminescence
- Water Color
- Biochemical Analysis
- Pigment Content
- Dissolved and Particulate Organic Carbon
- Sonar Graphs
- Commercial Fishing Reports
- Sport Fishing Catch Reports
- Fish Tagging
- Fish School Sightings
- Bird Flock Sightings
- Biological Sound Frequency
- Biological Sound Intensity
- Chlorophyll
- Bio-Assays
- Plankton Tow or Trawl
  - Type of Sampler
  - Direction of Tow
  - Depth of Tow
  - Volume of Water Strained
  - Net Condition
  - Winch Hauling Rate
  - Collector
- Occurrence of Fish Eggs & Larvae
- Others

Geological and Geophysical

- Bottom Samples
  - Type of Dredge
- Sediment Description
- Bottom Heat Flux
- Bottom Photographs
- Sediment Transport
- Sediment Distribution
- Geochemistry
- Sedimentation
- Bathymetry
- Texture
- Composition
- Color
- Carbon Content
- Carbonate Content
- Biostratigraphic Age
- Subbottom Seismic Profiles
- Magnetic Field
- Gravitational Field
- Seismograms
- Seismic Velocities
- Seismicity
- Permeability
- Porosity
- Gamma Log
- S P Log
- Resistivity Log
- Bottom Oxygen Uptake
- Sediment pH
- Sediment Eh
- Seafloor Volcano
  - Location
  - Size
- Seafloor Guyot
  - Location
  - Depth
  - Size
- Glaciologic Effects
- Drill Cores
  - Type of Corer
- Others

ATTACHMENT A
cont'd

Meteorology

Air Temperature
Air Pressure
Wind Velocity
Wind Force
Wind Direction
Humidity
Photographs - Cloud Cover
Solar Radiation
Air Samples
Precipitation
Weather (Clouds: Type, Amount, Fog, etc.)

Ozone Content
Radiosonde Observation (wind profile)
Condensation
Sunlight Intensity
Storm Frequency
Storm Severity
Cloud Type
Cloud Cover
Visibility
Insolation
Others

Pollution

Pesticides
Tetra Ethyl Lead
Industrial Chemicals
Waste Heat
Radioactive Waste
Detergents
Organic Waste
Biological Oxygen Demand
Coliform Bacteria
Oil - Grease

Phenols
Solids - Settleable
Solids - Suspended
Fecal Coliform Bacteria
Fecal Streptococci Bacteria
Pathogens
Viruses
Organic Nitrogen
Others

Acoustic Properties

Sound Velocity
Absorption
Intensity

Frequency
Others

Electrical Properties

Conductivity
Dielectric Constant

Attenuation
Others

ATTACHMENT A
cont'd

Optical Properties

Color
Absorption
Scattering
Reflection
Refraction
Radiance
Irradiance
Polarization
Transmission
Attenuation
✓Transparency
Others

Sea Ice

✓Ice Drift Direction
✓Ice Drift Speed
✓Ice Deterioration
✓Ice Detection
✓Ice Concentration
Iceberg Shape
Others

Engineering

Engineering Properties of Bottom
- Wet Unit Weight
- Specific Gravity of Solids
- Water Content
- Void Ratio
- Saturated Void Ratio
- Porosity
- Liquid Limit
- Plastic Limit
- Plasticity Index
- Liquidity Index
- Compression Index
- Compressive Strength
- Cohesion
- Sensitivity
- Angle of Internal Friction
- Activity
- Modulus of Elasticity
- Slump
- Stability

Corrosion
Coastal Erosion
Wave Forces
Wave Run-up
Wave Refraction, Reflection, Diffraction
Mass Flows
- Velocity
- Force
- Density
- Frequency
- Region of Occurrences

Others

ATTACHMENT A
cont'd

Socioeconomic

Ownership
International Treaties
International, National,
  Interstate Negotiations and
  Agreements
Requirements for National Defense
Federal Laws
State Laws
Local Laws
Law Enforcement
Population
Industrial Output
Water Withdrawl
  Municipal
  Industrial

Marinas
Recreation Demand
Port Charges
Labor Availability
Transport Availability
Import Tariffs
Obstruction Position
  Cables
  Pipelines
  Sunken Wrecks
Recreation Areas
Shipping Lanes
Restricted Area Boundaries
Others

Miscellaneous

Photographs
Microwave Images
Infrared Images

Television Images
Others

ATTACHMENT B

DATA FORMATS

- Handwritten or printed forms
- Scientific Publications
- Technical Reports
- ✓Magnetic Tape, Digital
- Magnetic Tape, Analog
- Paper Tape
- Punch Cards
- Listing of Descriptive Data
- ✓Digital Printout
- ✓Visual Analog Records
- Charts or Maps
- Specimens (Biological, Geological, etc.)
- Photographs
- Infrared Image
- Microwave Image
- Microfilm
- Microfiche
- Other (specify)
  ✓RATT (Radio Teletype)

APPENDIX C

MARINE DATA SERVICE

QUESTIONNAIRE

(EXAMPLE)

I. DATA PRODUCT

0\. Name of Data Facility — Oceanographic Mapping Branch, C&GS

		Actual	Desired
1.	Name of Data Product	Bathymetric Maps 1:250,000	1:62,500 (USGS requested)
2.	Contents	Seabottom depth contours	1:24,000
3.	Customers a. Identity	Oil Co., Scientist, Institute, Commercial Fisherman, Navy, CG, Army, Other agencies, State & Local	
	b. Total Sales	13,000 (FY1967)	
	c. Location	U.S. Continental Shelves Users	Same
4.	Geographic Coverage	U.S. Continental Shelf	Out to 1000 fathoms
5.	Format	C&GS format. Contours in meters (variable interval) scale 1:250,000	
6.	Volume per issue	3,500	
7.	Annual No. of new issues	4	Basic series (1:250,000) 160 map/5 years
.	Frequency of reissuing	None	In areas of changing bottom every 10 years; others 50 years. Also depends on updating for data inadequacy.
9.	Product transmission Method (mail, teletype, etc.)	Mail and over-the-counter	Same Computer interrogation
10.	Product transmission time to customer	Up to 1 week	Same
11.	Costs a. Direct costs compilation & reproduction	$12-15,000issue of 3,500	
12.	Quality Factors a. Accuracy b. Scale c. Resolution Detail	 ± 1/4 mi. (+1/16") 1:250,000 1/2 mile	 ± 1/8 mi. ± (1/32") 1:62,500 1/4 mile
13.	Remarks Compatibility (IHB Conventional mercator	Transverse mercator	

*Includes furnishing of data by data centers (Listings for example).

Interviewee:

Date: 11/13/68

II. DATA BASE

0. Name of Data Facility — Oceanographic Mapping Branch

1. Name of Associated Data Product. — Bathymetric Maps

2. Name of Data Base. — Bathymetric Data

3. Contents. — Corrected soundings & positions

4. Geographic Coverage. — Continental Shelf

5. Organization of Data Base (hierarchy). Registry Number

6. Storage Media. — Continuous Profile Record, cloth-mounted smooth sheet

7. Volume (number of entries). — 100 smooth sheets in branch; 12,000 in vault

8. Collection Date of Earliest Entry. 1835

9. Frequency of Updating. — continous

10. Annual Growth Rate (Additions-Purging). 30 to 60 smooth sheets/yr

11. Quality Factors: — See Hydro Manuals

    a. Accuracy.

    b. Precision.

    c. Environmental Factors.*

    d. Instrument (s).

    e. Platform (s).

12. Data Collector or Source of Data. USC&GS mostly (95%)(1968) U. of Wash, Oil Co.
    Some Navy & Institutions (5%)SIO, LaMont, Duke, Ore.St./
13. Format (punch cards, magnetic tape, etc.; try to obtain copy at data base layout).
    Punch cards (after 1966) & smooth sheet format-see Hydro Manuals)
14. Processing Operations Performed (computing, file maintenance, retrieval, etc.)
    File maintenance-as required; retrieval on request-1 day delay from vault.
15. Data Collector or Source of Data. Bathymetric data-NAVOCEANO, Institutions, International Halibut Comm., BCF, USGS, Bureau of Mines, Oil companies.

16. Remarks: Original smooth sheets are required because of the errors induced in photographic reproduction. Dimensionally unstable. Lack of color. Some proprietary data.

*Sea State, Weather etc. Interviewee: Date: 11/13/68

III. Input Data

0. Name of Data Facility. Oceanographic Mapping Branch

1. Name of Associated Data Base. Bathymetric Data

2. Name of Input Data. " "

3. Contents. Corrected soundings and positions

4. Geographic Coverage. U.S. continental shelf

5. Form of Data as Received at Data Facility (core, BT, mag. tape). Smooth sheet

6. Volume per Input. 1 smooth sheet/input

7. Annual Volume. 30 to 60/yr.

8. Date of Data Collection. June-Sept '68-(Norton Sound Project best example)

9. Date of Receipt at Data Facility. Early '69 "

10. Date of Input to Data Base. Early '69 "

11. Frequency of Receipt at Data Facility. Con't

12. Data Transmission Method to Data Facility (radio, mail, RATT, etc.).Mail. Standard verification and review procedures

13. Quality Control (calibration, editing, etc.). See Hydro Manuals

14. Quality Factors.) See Hydro Manuals
    - a. Accuracy)
    - b. Precision)
    - c. Environmental Factors*)
    - d. Instrument (s))
    - e. Platform (s))

15. Data Collector or Source of Data. USC&GS ships (95%); Navy & Institutions (5%) (Sanitized)

16. Remarks: (Chevron) Oil Co. Bathy. data on magnetic tape available, position of towed platform, not depth recorder given.

*Sea State, weather etc. Interviewee: Date: 11/13/68

IV. OTHER INFORMATION

0. Name of Data Facility. Ocean Mapping Branch, Marine Chart Division, Hydrography & Oceans, C&GS

1. a. Sponsors.

   b. Affiliations.

2. Arrangements for Data (product) Exchange. All informal.

   a. Federal. Navy (use bathymetric data library) only in area of activity

   b. State and Local. California (State Lands Division) also other states

   c. Industry. Exploratory attempts are under way with the oil companies (Chevron)

   d. Universities/Institutions. S.I.O., Oregon State, Univ. of Washington, Duke, Woods Hole

   e. International. Suspended due to lack of funds. [I.H.B. G.E.B.C.O. collection sheets - 1:1,000,000]

   f. Data Exchange Format Compatibility. Standard survey sheet format. Projection incompatible with IHB

3. Equipment (computer, tab. equip., publication equip., etc.). Standard cartographic instruments.

4. Space. Increase

5. Number and Specialties of Personnel. (Number of cartographers, 5; supervisor (Civil Engineer), 1

6. Personnel Training Programs (related to data management). On the job & night classes.

7. Planned Future Development Activities.

   a. Personnel. Increase by factor of 5 or 6 for 5-year 1:250,000 mapping series (does not include GEBCO).

   b. Equipment. Needs camera in division to reduce scales. Automate plotting, digitize present holdings, some automated contouring.

   c. Data Products. Gravity data, magnetic data, sediment sample data presented on bathymetric maps

   d. Data Bases None

   e. Data Collection. High-speed launches & multi-array instrumentation.

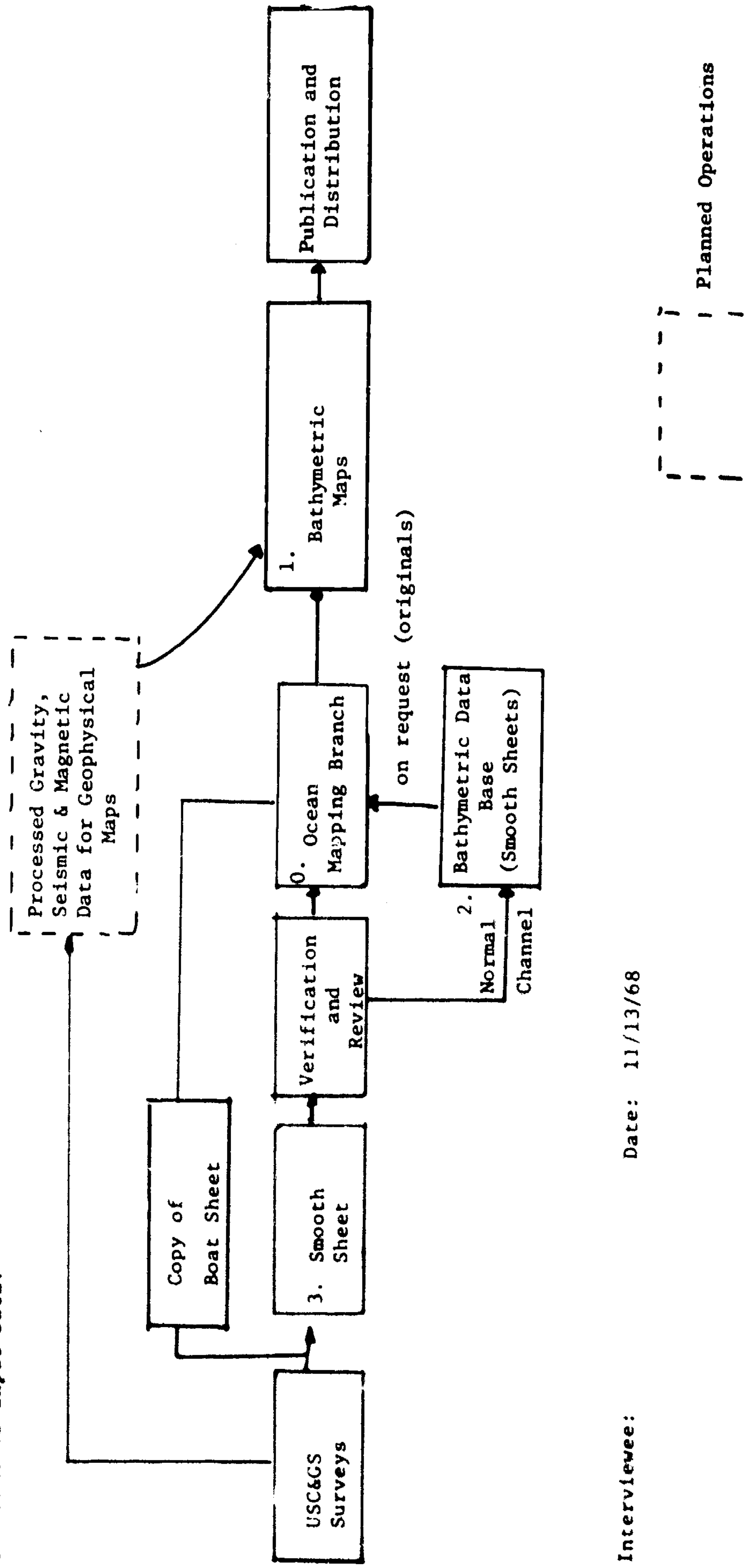
8. Remarks: (7C)Presentation of seismic data is also being considered. (2) Much work to be done in making arrangements

Interviewee: Date: 11/13/68

V. FLOW CHART

(Flow Chart of Data Base Maintenance & Data Product Preparation)

0. Name of Data Facility
1. Name of Data Product.
2. Name of Data Base.
3. Name of Input Data.



Interviewee:

Date: 11/13/68

APPENDIX D

PRIORITY DATA AND PRODUCT DETERMINATION TABLES

(EXAMPLE)

TABLE D-1

EVALUATION OF THE CRITICALITY OF
DATA FOR NATIONAL PURPOSES AND ASSESSMENT
OF UNFULFILLABLE DATA NEEDS

DATA PARAMETER GROUP	[illegible] PARAMETER	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	MARINE ENGINEERING	DEVELOPMENT AND CONSERVATION OF COASTAL ZONE	DEVELOPMENT OF NON-LIVING RESOURCES	HEALTH	TOTAL CRITICALITY
[illegible]	[illegible]	1	2	[illegible]	0	[illegible]	[illegible]	1	0	1	2	2	0	2	
	[illegible]	4	4	2	[illegible]	2	[illegible]	2	[illegible]	4	4	4	1	2	
	[illegible]	2	4	[illegible]	0	[illegible]	1	1	[illegible]	[illegible]	2	2	0	2	
	[illegible]	1	2	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1	0	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE D-2

ENVIRONMENTAL DESCRIPTIVE PRODUCTS
PRIORITY DETERMINATION

TABLE D-2 (CONT'D)

ENVIRONMENTAL FORECASTING PRODUCTS
PRIORITY DETERMINATION

PRODUCT	APPLICATIONS (EXAMPLES)	NAVAL OPERATIONS	ENVIRONMENTAL FORECASTING	ENVIRONMENTAL DESCRIPTION	FISHING	MERCHANT SHIPPING	MARINE ENGR. DESIGN & OPER.	INDUSTRIAL OPERATIONS	RESOURCE MANAGEMENT	RECREATION	NUMBER OF BENEFICIARIES	FREQ. OF BENEFIT (TIMES/YR)	TIME DUR. OF BENEFIT	USAGE (PEOPLE-HRS PER YEAR)	REMARKS
COASTAL WEATHER FORECAST	SURF FORECASTING		[illegible]								[illegible]		[illegible]	[illegible]	COASTAL WEATHER AFFECTS SURF CONDITIONS. [illegible]
	VESSEL OPERATIONS	A [illegible]			A [illegible]	A [illegible]		A [illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	COASTAL OPERATIONS						A [illegible]	A [illegible]							
	RECREATIONAL FORECASTS									A [illegible]					
	SUBMERSIBLE OPERATIONS						A [illegible]								
TOTAL														[illegible]	
SEA SURFACE TEMPERATURE CHART	[illegible]				[illegible]						[illegible]			[illegible]	[illegible]
	[illegible]	A [illegible]									[illegible]			[illegible]	[illegible]
	[illegible]		A [illegible]								[illegible]			[illegible]	[illegible]
	[illegible]						A [illegible]				[illegible]				
	[illegible]										[illegible]			[illegible]	[illegible]
TOTAL											[illegible]			[illegible]	
[illegible]	[illegible]	[illegible]			[illegible]		[illegible]	[illegible]			[illegible]			[illegible]	[illegible]
TOTAL											[illegible]			[illegible]	
[illegible]	[illegible]				[illegible]						[illegible]				[illegible]
[illegible]	[illegible]										[illegible]			[illegible]	[illegible]
FISHERY STATUS REPORTS	[illegible]										[illegible]		[illegible]	[illegible]	[illegible]
TOTAL											[illegible]			[illegible]	
[illegible]	MARINE WEATHER FORECASTS	[illegible]	[illegible]			[illegible]					[illegible]			[illegible]	[illegible]
	[illegible]	A [illegible]									[illegible]			[illegible]	[illegible]
TOTAL											[illegible]			[illegible]	
HURRICANE ADVISORIES	[illegible]					[illegible]					[illegible]		[illegible]	[illegible]	[illegible]
TOTAL											[illegible]			[illegible]	
[illegible]	[illegible]	A				[illegible]	A	[illegible]		[illegible]	[illegible]				[illegible]

TABLE D-2 (CONT'D)

ENVIRONMENTAL FORECASTING PRODUCTS
PRIORITY DETERMINATION (CONT'D)

PRODUCT	APPLICATIONS (EXAMPLES)	NAVAL OPERATIONS (27)			ENVIRONMENTAL FORECASTING (9)			ENVIRONMENTAL DESCRIPTION (22)			FISHING (18)			MERCHANT SHIPPING ([illegible])			MARINE ENGR. DESIGN & OPER. (11)			INDUSTRIAL OPERATIONS (5)			RESOURCE MANAGEMENT (3)			RECREATION (1)			NUMBER OF BENEFITTERS	FREQ. OF BENEFIT (TIMES/YR)	TIME DUR. OF BENEFIT (HRS/TIME)	USAGE (PEOPLE-HRS PER YEAR)	REMARKS
		IMP	P	UN	IMP	P	UN	IMP	P	UN	IMP	P	UN	IMP	P	UN	IMP	P	UN	IMP	P	UN	IMP	P	UN	IMP	P	UN					
TSUNAMI WARNINGS	PUBLIC SAFETY																									2		T(1)	20M	5	1	$1X10^8$	ONLY PACIFIC BASIN RESIDENTS AFFECTED.
	COASTAL OPERATIONS	2		T(3)							2		T(1)	2		T(1)	2		T(3)	2		T(3)											
HIGH SEAS FORECASTS	VESSEL OPERATIONS	2		A(2)										2		A(2)													65K	400		$26X10^6$	ALL VESSELS AT SEA 200 DAYS/YEAR; FORECASTS USED TWICE DAILY FOR 1 HOUR.
	SHIP ROUTING	4		A(3)										4		A(3)													65K	400	1		
	SURF FORECASTING				2		A(3)																						1.3M	2	2	$136X10^6$	NO. PEOPLE USING SURF FORECASTS.
TOTAL																													[illegible]			$262X10^6$	
SATELLITE INFRARED MAPS AND CHARTS	SEA ICE FORECASTING				2		I(2)																						1500	150	12	$6.5X10^6$	40 SUBMARINE CREWS, 200 MERCHANT SHIP CREWS, USING TWICE DAILY FOR 6 MONTHS.
	DOMESTIC ICE FORECASTING (G.L.)				2		V(2)																						50K	26	2		50K PEOPLE AFFECTED IN GREAT LAKES AREA USING 1 FORECAST/WEEK FOR 6 MONTHS.
	LONG-RANGE FORECASTING				4		V(2) D(4) G(2)																						72M	52	1	$3.7X10^9$	COASTAL RESIDENTS GETTING WEEKLY EXTENDED FORECASTS, USING EACH ABOUT 1 HOUR.
	HURRICANE DETECTION				2		D(2)																						10M	5	2	$1X10^8$	FIVE HURRICANE ADVISORIES FOR PEOPLE ON GULF AND EAST COASTS.
	ASWEPS	4		A(2) D(1)																									11K	200	1	$22X10^5$	PERSONNEL AT SEA ABOUT 200 DAYS/YEAR.
	FISH LOCATING										2																						FUTURE USE.
TOTAL																													102M			$[illegible]X10^9$	
SATELLITE BRIGHTNESS (DIGITAL) CHARTS	MARINE WEATHER FORECASTING				1		T																						72M	360	1	$1.3X10^9$	ALL COASTAL RESIDENTS BENEFIT FROM DAILY MARINE WEATHER FORECASTS.
SATELLITE PHOTOS	MARINE WEATHER FORECASTING				2		V(1)																						72M	360	1	$1.3X10^9$	ALL COASTAL RESIDENTS BENEFIT FROM DAILY MARINE WEATHER FORECASTS.
	HURRICANE DETECTION				4		V(2)																						10M	5		$1X10^8$	HURRICANE AREA RESIDENTS RECEIVE HOURLY ADVISORIES ON APPROXIMATELY 5 STORMS/YEAR.
	VESSEL OPERATIONS	1		V(1)										1		V(1)																	
TOTAL																													[illegible]			$1.4X10^9$	
PREDICTION OF EFFLUENT DISPERSION	POLLUTION CONTROL	1		G(1)										1		G(2)	4		A(2) I(1) G(2)				4		A(2) I(1) G(4)	1		I(1) G(2)	[illegible]				
SEA-STATE FORECASTS	VESSEL OPERATIONS	2		A(2)							2		A(1)	1		I(2)													66K	200	1	$13.2X10^6$	ALL VESSELS AT SEA ABOUT 200 DAYS/YEAR.
	SHIP ROUTING	4		A(2)										4		A(2)																	SAME PEOPLE AFFECTED AS ABOVE.
	COASTAL OPERATIONS																2		A(2)	2		A(1) G(2)							20K	365	1	$3.65X10^6$	MERCHANT SEAMEN INCLUDED ABOVE
	SUBMERSIBLE OPERATIONS																4		A(1) G(4)														
TOTAL																													[illegible]			$16.85X10^6$	
EXTENDED WEATHER FORECASTS	SHIP ROUTING	4		A(3) G(1)										4		A(3) G(1)													66K	200	1	$13.2X10^6$	
	MARINE WEATHER FORECASTING				2		A(1) G(1)																										
	CONTINENTAL FORECASTING				4		A(3) D(1)																						200M	26			
	COASTAL OPERATIONS																1		A(1) G(2)	1		A(1) G(2)				1		A(1)					
TOTAL																													200M				
ROUTING CHARTS AND REVISIONS	VESSEL OPERATIONS	2		A(1) G(1)										2		A(1)													1650	365	12	$7X10^6$	33 MERCHANT VESSELS (EACH WITH 50 MEN) ROUTED (COMMERCIAL) EACH DAY -- CHARTS GOOD FOR 12 HRS.
																													1650	365	12	$7X10^6$	33 MSTS VESSELS ROUTED BY USN.
																													1000	365	12	$13X10^6$	300 NAVY SHIPS AT SEA CONTINUALLY. THIS IS A POTENTIAL FOR ROUTING, SINCE ONLY A SMALL NUMBER NOW USE ROUTING CHARTS.
TOTAL																																$27X10^6$	

TABLE D-2 (CONT'D)

ENVIRONMENTAL FORECASTING PRODUCTS
PRIORITY DETERMINATION (CONT'D)

PRODUCT	APPLICATIONS (EXAMPLES)	NAVAL OPERATIONS (17) IMP P SN	ENVIRONMENTAL FORECASTING [illegible] IMP P SN	ENVIRONMENTAL [illegible] IMP P SN	FISHING [illegible] IMP P SN	MERCHANT SHIPPING [illegible] IMP P SN	MARINE ENGR. DESIGN & OPER. (11) IMP P SN	INDUSTRIAL OPERATIONS (5) IMP P SN	RESOURCE MANAGEMENT (3) IMP P SN	RECREATION (1) IMP P SN	NUMBER OF BENEFICIARIES	FREQ. OF BENEFIT [illegible]	TIME CRIT. OF BENEFIT [illegible]	VALUE [illegible] PER YEAR	REMARKS
DOMESTIC ICE FORECASTS	GREAT LAKES SHIPPING					A( )					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ESTUARINE FLUSHING PREDICTIONS	POLLUTION CONTROL						A( ) ( ) ( )	A( ) ( ) ( )	A( ) ( ) ( )		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
GREAT LAKES WATER LEVEL PREDICTIONS	GREAT LAKES SHIPPING					( )					[illegible]	[illegible]	1	[illegible]	[illegible]
	POLLUTION CONTROL								( )		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	COASTAL OPERATIONS						( )				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL											[illegible]			[illegible]	
WATER QUALITY REPORTS	POLLUTION CONTROL								A(2) ( )		[illegible]	[illegible]	[illegible]	28.8X10^6	[illegible]
	VESSEL OPERATIONS					A( ) ( ) ( )					[illegible]	[illegible]	1	[illegible]	
	GREAT LAKES SHIPPING					A( ) ( )					[illegible]	[illegible]	1	[illegible]	
	COASTAL OPERATIONS						A( ) ( ) ( )								USED FOR COASTAL ENGR. PROJECTS AS REQUIRED.
TOTAL											[illegible]			28.8X10^6	
SEA ICE FORECASTS	VESSEL OPERATIONS	A( ) ( )									[illegible]				[illegible] NUCLEAR SUBS AND [illegible] SURFACE VESSELS. ALL DEFENSE.
	COASTAL OPERATIONS														
ICEBERG ADVISORIES	VESSEL OPERATIONS														
SURF FORECASTS	COASTAL OPERATIONS	A( )				A( )	A( ) ( )		2 A( ) ( )	1 A(1) ( )					
	PUBLIC SAFETY									1 A(1) ( )	[illegible]	[illegible]	[illegible]	216X10^6	[illegible] SWIMMERS.

UNC.

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) System Development Corporation Santa Monica, California	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

VOLUME ONE NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
31 July 1969	511	

8a. CONTRACT OR GRANT NO. N00014-67-C-0559 b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) TM-4023/005/00 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

Distribution of this document is unlimited

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

Reports on a study made by System Development Corporation to assist in the expansion of marine science and ocean related activities.

The report is in two volumes. Volume I: National Data Program for the Marine Environment (TM-4023/005/00) and Volume II: Technical Development Plan for the Marine Environment (TM-4023/006/00).

DD FORM 1 NOV 65 1473

Unclassified

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Marine environment						
Marine data management						
Marine data network						
Geographic coverage						
Weather observations						
Marine science						
Oceanography						